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Compressed Air Magazine

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"JACKHAMER" EQUIPPED WITH TWISTED AUGER STEEL DRILLING IN NARROW VEIN OF ANTHRACITE COAL

The Reconstruction Problem in the Lens Coal Mining District
Charles Moreau

Cutting Metals Under Water
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Increasing Use of Compressed Air in Coal Mining
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C. Kenneth Smullen

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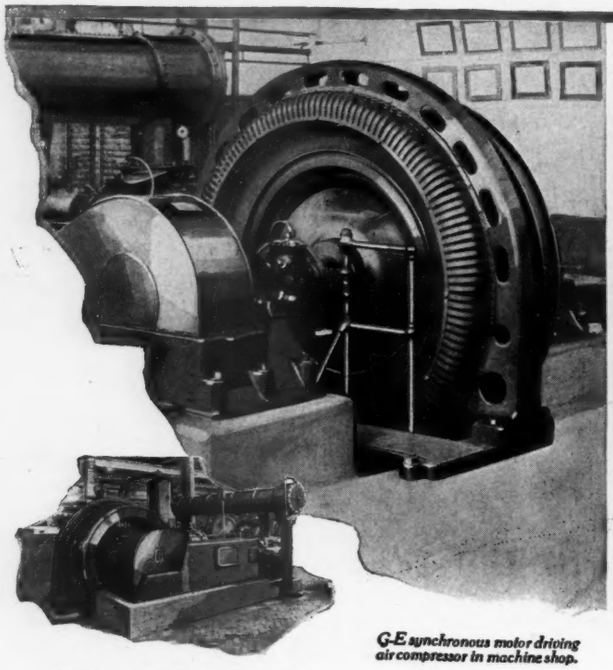
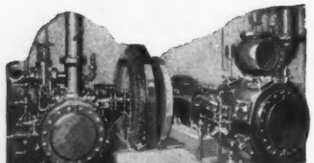
In many mills, factories, and shops—synchronous motors are as essential to economy as good management



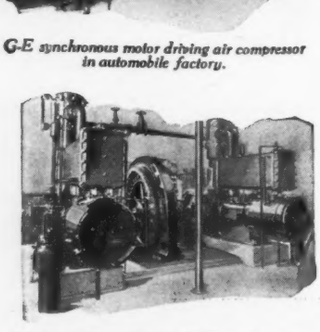
A big electrical industry uses this G-E synchronous motor for driving air compressor.

G-E synchronous motor driving air compressor in machine shop.

One of many installations of G-E synchronous motors driving air compressor in shipbuilding plant.



G-E synchronous motor driving air compressor in automobile factory.



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MAY, 1922

The Reconstruction Problem in the Lens Coal Mining District

Development Work and Coal Production Accomplished Prior to Destruction by the Germans at the Properties of the Societe des Mines de Lens— Progress in Restoration of Mines Since Armistice

By CHARLES MOREAU
Chairman, Society for the Reconstruction of Lens.

THE "SOCIETE Des Mines de Lens" was established in 1852. It met with numerous difficulties at the start and the sinking of shaft No. 1 meant considerable effort and sacrifice. The perseverance of the founders, however, never wavered. In 1857, the sinking of shaft No. 2 was undertaken. Two years after actual work started at this pit, a very rich seam was discovered, and from this date, the great success of the Mines de Lens was established.

In 1879, shaft No. 5 was started, and shortly afterward a modern shaft equipment was built adequate for working such an important deposit of coal.

Since then the number of hoisting shafts have constantly increased, and in 1914 the mine had 28 pits, nineteen of which were working, the deepest going down 2,540 feet. The total production since the beginning amounted to more than 95 million tons and the annual output reached four million tons with 16,000 miners employed. This was one-tenth of the total production by the French. The variety of the veins permitted furnishing for industrial and domestic consumption, coals of all kinds and suitable for all uses.

The "Mines de Lens" were among the first collieries of North France to develop plants for the treatment of poor coals, such as cleaning and washing plants, carbonizing, bricket presses, etc. In 1914, the Mines de Lens had eight washing plants; one standard bricket plant; one small bricket (balls) plant for home use and 764 coke ovens, amongst which 524 in continuous use were producing 620,000 tons of coke a year.

All the coke ovens were provided with by-products recuperating apparatus and from the distillation of 35,000 tons of coal tar there were produced:

17,600 tons of hard tar
8,200 tons of tar oil
2,000 tons of napthalene
1,400 tons of anthracene
4,400 tons of benzol
6,700 tons of sulphate of ammonia

A special plant, the only one in France at the time, was making pure anthracene which could be used direct for the production of dyeing stuffs. The excess of coke oven gas was used for running big gas engines in four central stations and the electric current produced was distributed to several companies belonging to the "Mines de Lens."

The railway system covered a length of 135 miles and the rolling stock included 50 locomotives and 2,500 cars. The company owned, at the harbor of Pont-à-Vendin, on a barge canal, a big coal handling plant which could load in barges, 900 tons of coal an hour, using a device invented by Mr. Reumaux, general director of the Company.

In 1913, the tonnage of the Pont-à-Vendin harbor was over 1,200,000 tons, including 1,000,000 tons of coal and coke.

A few years before the War, the Société des Mines de Lens with the Société des Forges and Aciéries de Commentry-Fourchambault entered into a corporation which was called the Société Métallurgique de Pont-à-Vendin. This organization was for the purpose of managing blast furnaces, steel plants and rolling mills. The production of pig-iron could have reached a production of 225,000 tons a year when started. The steel plant was nearly completed in 1914, and the blast furnaces could have been filled in the beginning of 1915.

From a social as well as a technical point of view, the Société des Mines de Lens had always been noted for the rapid development of their mines and contributed very much to the prosperity of the entire district.

In 1852, the town of Lens had hardly 3,000 inhabitants. In 1914 there were more than 32,000 inhabitants and the 16,000 workmen and employees of the company represented, with their families, a population of 70,000 people living around the principal working centers.

The management of the Lens mines had made great sacrifices to lodge the greatest part of their workmen under the best and most comfortable conditions, and in 1914 they had about 8,000 houses divided into fifteen vast cities, well aired, and with 9,000 gardens. Each house was let for a price varying from four to 10.50 francs per month.

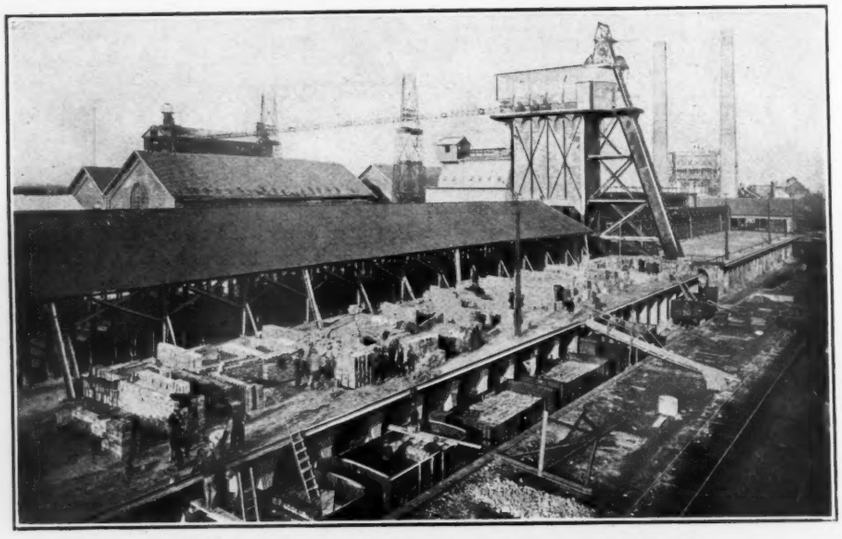
Girls' and boys' schools were built so that about 6,000 children could receive instruction. Kindergartens, workshops, dressmaking shops, and flower gardens were annexed to such schools. Churches, dispensaries, nursing homes, a large hospital with all modern improvements, and a hall, completed the organi-

THE HUGE task of reclaiming the coal mines of the famous Lens district is being accomplished only by the expenditure of extraordinary efforts since the war and will require several more years to place the properties on a pre-war production basis.

Not alone does the problem involve the restoration of the mines but a still more difficult accomplishment is the reconstruction of houses for the working people.

It will require nearly 400 million francs to build the necessary 12,000 to 15,000 houses required. Brick making plants and tile works have been installed and sand and gravel pits have been opened in order to provide the necessary material.

One of the semi-completed shaft houses and head frames at property of the Societe des Mines de Lens.



Battery of coke ovens under construction at Pont-a-Vendin.

Interior view of mechanical stoker at the boiler plant of the Central Electric Power Station showing state of reconstruction work in October, 1921.

zation of the cities. Nothing was spared to make everything look as cheerful as possible.

All these efforts had a good result. In 1914 the working output was very important; the people were grateful for the sacrifices made for them and liked the work at the mines and the life in the cities. The increase in the number of births and the good health of the children were a proof of happiness and prosperity.

German Occupation

The Lens district was invaded on October 4th, 1914. It was attacked three times and was entirely destroyed.

The counter attack of September, 1915, liberated Loos and the No. 15 shaft, the firing-line of the Allies being carried on to Liévin. The attack in the spring of 1917 permitted the Canadians, passing over the cliff of Vimy, to progressively push their quarters right into the Lens suburbs, clearing the southwest part of the mine and four of the shafts.

Eighteen months later, the final retreat of the enemy liberated the whole of the district. The enemy left Lens on October 4th, 1918, after four years of occupation.

During the months of August and September, 1914, it had been possible to continue work in the mine though a large number of the men had been mobilized, but, it had to be stopped on the 4th of October. As soon as the Germans occupied the mine, they destroyed all means of working; the ropes were cut, the drawing cages and cars were thrown into the shafts and the principal parts of machinery broken.

The staff remaining at the mine under the direction of Mr. Reumaux, who gave to all a splendid example of the highest civic virtues, devoted all their activity to preventing further damages and doing all they could to try and keep the work in order at the bottom of the shafts.

All filled their task with a courage and zeal which deserves acknowledgment. The enemy made it very hard for them, hindering them from approaching the shafts and works, and forbidding them to be out after 4 P. M.

The plan of the enemy was most unfair. They wanted our ruin and their plan for reaching it was methodically worked out. The Allies' attack on the Loos-Vimy line in the Spring of 1915, in shaking the enemy's firing-line, hurried its execution. They used explosives extensively doing more damage than would have been done by the strongest bombardment. The derricks, engine cylinders, and boilers were all undermined.

At the bottom of the shafts, where there was no adit, the water was rising little by little, too slowly though for the enemy's desire, who then decided to inundate the galleries by having the shaft linings blown up.

In spite of the protestations of Mr. Reumaux, who insisted upon the important consequences of such a measure—useless from the military point of view—and in spite of the offer he made to obstruct the mouth of the shafts, the operation was carried out by means of explosive cartridges placed against the shaft linings.

At the end of 1915, the ruin of our whole plant was accomplished. All that was left

which could still be used—stocks of all kinds, material and machines in good state—were seized and sent away.

Our agents had thus the sad experience of seeing that all their efforts and sacrifices had been useless. Some of them were killed or wounded in doing their duty and many of them were sent to Germany and imprisoned there. The others left the town with the rest of the population in April, 1917, during the British attack, which was stopped on a line surrounding Lens, without being able to relieve it. The unfortunate town was bombarded for eighteen months longer. When the enemy retreated it was just a heap of ruins, a desert without any life at all.

Reconstruction

Over a surface of more than 15,000 acres, there was neither an inhabitant nor a habitable house left; the ground had been entirely turned up, the roads were impassable and the railways entirely destroyed. The whole town and the suburbs were just like an immense field of ruins.

The mining plants were a huge heap of tangled irons and the devastation was far more disastrous than it looked on the surface, as the German Army started the destruction of the plants in 1915 and completely flooded the underground workings.

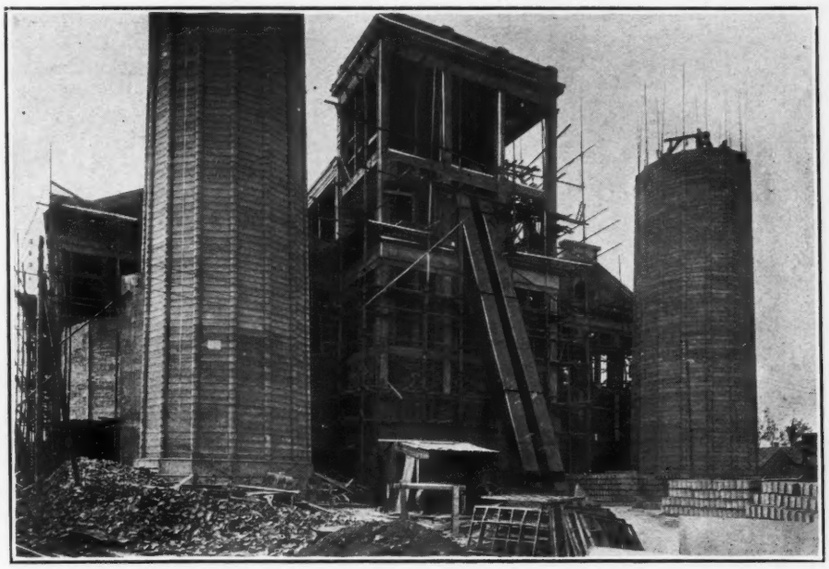
The first thing needed therefore, was to bring life again into such a desert and to put a little order in the ruins. The first work done was to rebuild the railway from Pont-à-Vendin to Violaines. In May, 1919, the railroad was restored for a length of about ten miles and the first trains started running.

Then we had to start clearing away the debris. All important material was collected and the Sté. des Mines de Lens accomplished that part of the work in about twenty months with, of course, reduced staff and equipment.

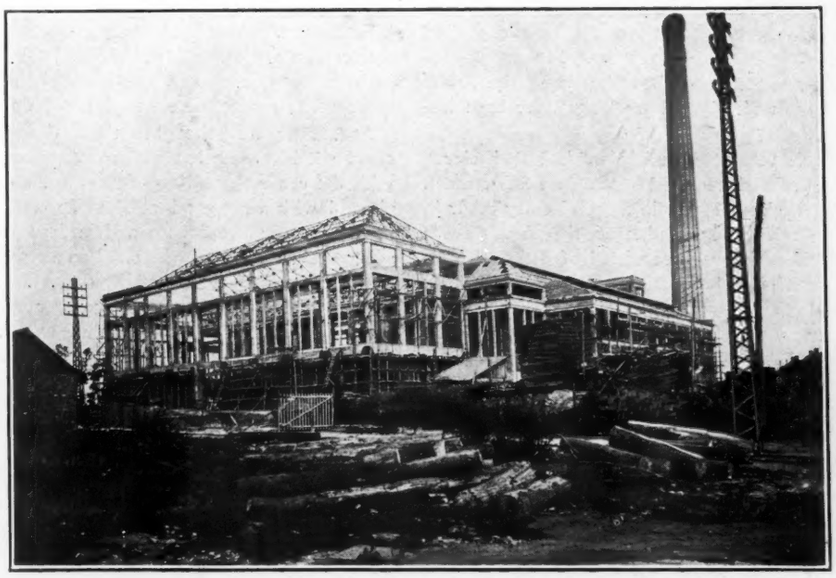
The next step was to start the pumping work. For that purpose, considerable equipment was bought in 1916 and more at the beginning of 1918, but before such material could be put in action, it was necessary to do important preliminary work.

Everyone knew that the enemy had undermined the linings of the two shafts, Nos. 9 and 11, and everyone hoped that was all the harm that had been done, but the information obtained in response to inquiries made after the Armistice and which only reached the mine in October, 1919, was absolutely disheartening. Except for pits Nos. 15 and 16, taken back in 1915, nearly all the other shafts of the mine had been undermined and detailed information was found regarding 22 of them. It showed plainly the enemy's careful plan of complete destruction.

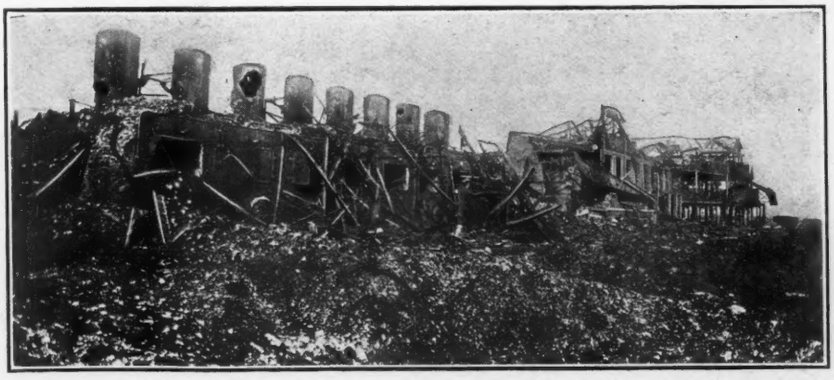
In wrecking the shafts the procedure was as follows: At each end of a beam of the same length as the diameter of the shaft, they placed an explosive charge of about 220 lbs. Such a beam was lowered down the shaft and when it had reached the depths at which the enemy knew (through their specialists) that there was a weak point in the lining or an underground water-level, the beam was placed horizontally. The two bursting charges against



Southeast side of Central Electric Power Station showing progress of reconstruction in October, 1921.



A general view of central power station at Mines de Lens, October, 1921.



Destruction wrought by the Germans at Pit No. 13 on the property of Societe des Mines de Lens.

Progress of reconstruction work accomplished since the Armistice at Pit No. 13.

the sides of the shaft and the detonation caused a large breach in the lining.

In some of the shafts, such operations had been repeated several times: four times at pit No. 12 and five times at pit No. 14. The quantity of water let in through the openings made in the lining, was such that the pumping could not be continued. Something else had to be done.

It was by means of the previous grouting of the ground, a process invented by Mr. Porter, an engineer of the district, that the linings were replaced and the columns of the shafts and the underground workings have been isolated.

Such cement grouting work lasted eleven months, and required 9,000 tons of cement. It was accomplished in a satisfactory manner, and on November 2nd, 1920, the pumping was started. The work consisted of drawing from the shafts and galleries a quantity of water equal to 13,250,000,000 gallons, 9,250,000,000 gallons of which were from the Lens mine alone.

At first only one pump was working; then three, and afterward five were put at work, some of them of 540 h.p. and delivering, at the beginning 625,000 gallons an hour. The work accomplished was pumping out the columns of the shafts to the top of the coal formation, about 260 ft. under sea-level. This took until February 12th, 1921. At that time about 925,000,000 gallons of water had been pumped.

During all that time, while repairing the breaches in the shaft linings, clearing away material of all sorts, ropes, cars, etc., which the Germans had thrown into the shafts there was only one serious difficulty. At pit No. 10, which, according to information given by the Germans it was not necessary to cement, the lowering of the level of the water disclosed a breach from which an immense quantity of water was flowing and which had been made in unstable ground, at a depth quite different from the one stated as an explosion point.

At first, we thought that the shaft could not be saved, but we proceeded at once with the cement grouting of the inside of the pit and with very good results. In 48 hours there was no more danger and in fifteen days after the hole was stopped. From January, 1921, i. e. seven weeks after the first pump had been started, all the pumping work was over. Then on February 12th, 1921, the first pit-eye (about 260 ft. under sea-level) could be seen at pit No. 15, and several days after, coal was extracted. The drawing work only started on March 1st.

The second period (pumping from top of the coal formation to the first important mining floor 600 feet under sea-level), lasted until September, 1921. At that time nine pumps were running, and the quantity of water pumped since the beginning amounted to 4,000,000,000 gallons.

During the period, from the lowering of the level of water down to 535 feet under sea-level, the large coal-basin formed by both the Lens and Meurchin districts, the shafts of which communicated together, was divided into two principal coal-basins. The Reumaux dike, which separated the shafts of the North veins of dry burning coal from those of the South veins, of rich coal, indicated the dividing point.

When the water-level was low enough, the passage of the water between the various shafts was impossible and consequently two principal sections in the mine were formed. After a while, and following the lowering of the water-level, each section was divided into several portions, some shafts, like the No. 8, constituting a separate reservoir. It was then necessary to make proper arrangement of the pumps for working each of these separated reservoirs.

After each level was free of water, the shafts were repaired and provided with new equipment; the galleries were repaired and rendered suitable for use. The actual coal extraction was resumed at some of the pits on the following dates:

DATE	PIT	DEPTH BELOW SEA LEVEL
March 11th	No. 15	260 ft.
June 9th	" 2	375 ft.
August 8th	" 16	470 ft.
" 20th ...	" 11	470 ft.
September 1st ..	" 14	440 ft.
" 17th..	" 12	470 ft.

On Dec. 31, 1921, the water-level was at 690 ft. under sea-level, representing a total dewatering of 760 ft. since the beginning. The quantity of water pumped from the start was $4,765,000,000 gallons, i. e., a little over a third of the total volume of water to be pumped.

Nine pumps are now working at pits Nos. 2a, 3a, 5, 5a, 8 and 9a for the group of the southern shafts; 7, 7a and 13 for the group of northern shafts, but their delivery which was very important at the beginning (as previously stated, was 625,000 gallons an hour for each pump) has very much decreased because of the height of the column of water to be raised. The delivery is now about 66,500 gallons an hour for the "Sulzer" pumps and of 133,000 gallons for the "Boving" pumps.

As the height of the columns of water in-

General view of the location of Pits Nos. 9, 11, and 12 in August, 1921.

creases modifications must be gradually made in the discharge device of the pumps and the operation of pumping becomes a long and tedious job. We expect to reach the last pit-eyes for the deep shafts of the southern subdivision, (at 1235 ft. under sea-level), in about eighteen months.

The electric current necessary for the work of reclaiming the veins and the reconstruction of all the plants, is provided by the central station of the Mines de Bethune and by the Sté Electrique des Houillères, which consist of four turbines of 6,000 kw. In a short time, the first turbine of the central station of 60,000 kw. which the Société des Mines de Lens is building at Vendin-le-Vieil will be running.

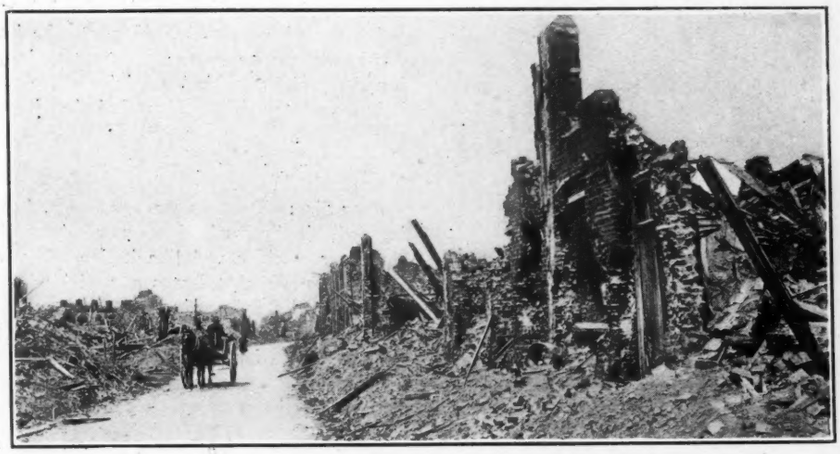
At the same time as the pumping of the underground works goes on, the plants above ground are being installed with hoists, compressors, ventilators, and the model lodging quarters are being rebuilt. Fifteen electric hoists of 90 h.p., twenty of 430 h.p. and two steam engines are running, as well as seven air compressors, four of 115 h.p. and three of 400 h.p. One washing plant is also working. A battery of 140 coke-ovens, including the works for the corresponding by-products, is in the most part rebuilt and the construction of a factory for the distillation of 50,000 tons of tar per year is well under way.

In regard to the railways, about 102 miles of track have been restored and the rolling stock consists of sixteen locomotives and 1,000 cars. In several of the shafts, coal extraction was restarted at the same time as the galleries were cleared. The production now amounts to about 20,000 tons per month, and one foresees that it will amount to 500,000 tons in 1922 (only one-tenth of the pre-war production), and in the following years, 1,250,000, 1,800,000 tons, etc., but it is difficult to foresee any further, as the production will depend on labor conditions.

The reconstruction of the houses for the working people in the Lens district is a problem which is perhaps still more difficult of solution than that of the restoration of the mines. We have already said that the Mines de Lens had, before the War, 8,000 workmen's houses. About 30 of them have been repaired, all the rest have to be rebuilt. If one takes into account the complete destruction of all the villages around, where about one-third of the miners lived, and also the results of the law limiting a day's work to eight hours, one comes to the conclusion that the Mines de Lens will have to rebuild 12,000 to 15,000 houses before attaining pre-war production.

It also involves an expense of more than 400 million francs in the preparation and bringing together of a considerable amount of materials. The Sté des Mines de Lens has installed a huge brick-making shop at Douvrin. They have also sand-pits, gravel-pits, tile-works, etc., in order to prepare the materials which are needed by them.

At the end of December, 1921, the number of houses rebuilt and inhabited amounted to 2,357. The staff, employed at the present time in the reconstruction of the mine, consists of 44 engineers or department managers, 353 employees and 5,099 miners. To this number must be added about 5,000 miners belonging to important enterprises of which the Mines de Lens have asked their help.



Typical street scene near Pit No. 9 after destruction by the Germans.

The worst part of reconstruction is now over. The realization of the programs set forth and the restoration of the plants which have been destroyed are now well under way. If the financial means are sufficient and if the Government can give the invaded collieries all the help they want, their work will continue with rapidity and their production will increase quicker than one could have hoped for. In several years, the Lens district will be as active as it was before the War.

The excellent results have been due to the ability and hard work of the engineers who have found ways to solve the problems; and to the staff whose zeal enabled the work of reconstruction to be rapidly started and whose perseverance will eventually result in the disappearance of all the consequences of this biggest mining calamity.

It is agreeable to think once more that even if our enemies are the masters of destruction, they are not so clever when it comes to repairing or rebuilding.

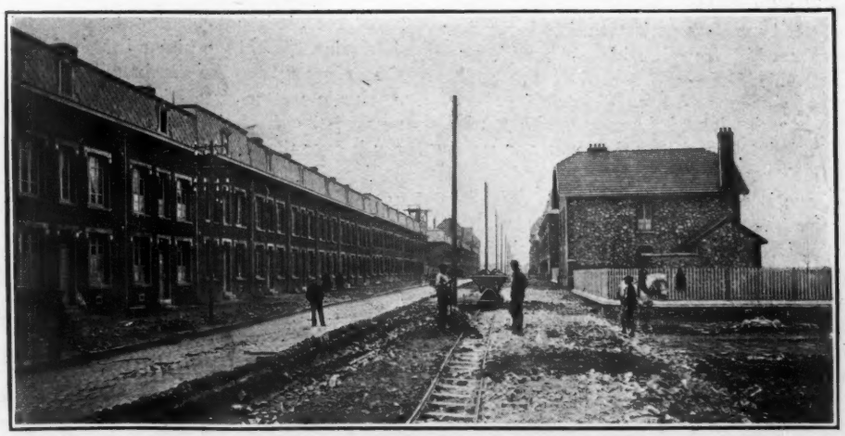
Several months ago, when the Germans were requested to start the reconstruction of the invaded districts, the engineers of Westphalia, the same ones who had organized and executed the destruction of our mines declared that they would not undertake such work, considering that it was very risky and even impossible in some of the shafts.

WHITE MOTOR CUTS DOWN PLANT-PAINTING COST

THE CLEVELAND plant of the White Motor Company is being thoroughly cleaned and painted, the latter operation requiring no less than 4,000 gal. of white semi-gloss factory paint, reports *Industrial Power*. Five painters and five clean-up men, all regularly employed by the company, will spend five months on this job, which was started January 3.

To cut down the cost of this big undertaking as much as possible, the spray method of applying the paint was adopted. By its saving of both labor and material, the total cost is reduced fully 50 per cent., which in this case means the time of ten men for five months—an aggregate saving in round numbers of $8,000 or more on the job.

The U. S. Bureau of Mines has completed an investigation of gas masks for use of train crews in railroad tunnels. Results of the tests will soon be published by the Bureau in a technical paper entitled "Tests of gas masks and respirators for protection from locomotive smoke in railroad tunnels with analyses of tunnel atmospheres," by A. C. Fieldner, S. H. Katz, and S. P. Kinney. A small mask was devised that fits conveniently into a coat pocket, and in actual service with locomotive engineers and firemen was found to last two to six months before distasteful gas penetrated.



A reconstructed street in a colliery town of the Societe des Mines de Lens in April, 1921.

DRILL STEEL—BITS AND SHANKS

[Drill steel has always been a much discussed subject and it probably will continue to be as long as there is rock to drill and blast. We are continually receiving letters asking for advice on various phases of this subject. Most of these questions and their answers are of interest to a large part of our readers, and therefore this column is published in order to give our readers the benefit of the service that we have been rendering through this correspondence. Questions are especially invited which have to do with any phase of forging, tempering, and the care of drill bits and shanks. Our answers, based on the best modern practice, will be published in succeeding issues.—ED.].

Compressed Air Magazine,
New York City.

Dear Sirs:—My drill steels have been breaking frequently, most always about one and one-half inches below the collar on my Jackhamer steel. I know there must be something wrong with the way we handle the steel because this happens so much in the same place. Can you tell me the cause of this trouble and what can I do to stop it.

Poughkeepsie, N. Y. F. S.

* * *

The point at which you say the breakage occurs is the boundary point of the forging heat beyond which the steel has remained comparatively cold. To overcome this we would recommend plunging the shank in a soluble quenching oil about six inches from the end of the shank. This will relieve the strains set up by the forging heat. Care should be taken that for the tempering heat a temperature of approximately 1470° should be obtained.

* * *

Compressed Air Magazine.

Dear Sirs:—I am drilling rock for a foundation and using two and one-eighth inch, two and one-quarter inch, and two and three-eighths inch bits. I am sending several samples of broken bits so that you can have a better idea of how this happens. On the smaller size bits I do not have this trouble. Will you please tell me if there is anything I can do to stop these bits from breaking. Thanking you.

Pottsville, Pa. R. T.

An examination of the sample bits you have forwarded to us shows that you are making and resharpening these bits by hand. If this breakage is confined wholly to the three largest size bits we believe you will find that the trouble is due to the manner in which the upsetting dolly is used. The blacksmith's helper is undoubtedly striking this dolly so as to bend the bits on one side and then on the other and this condition would be pronounced on the larger bits such as the sizes you have specified.

This trouble can of course be entirely eliminated by using a drill sharpening machine, but if this is out of the question, some improvement can be made by teaching the helper to strike the dolly squarely. You may be interested to know that many operators are installing sharpening machines on jobs where there is but one rock drill. They find that it pays.

* * *

Compressed Air Magazine,
New York City.

Dear Sirs:—Twenty years ago I started making drill bits by hand. I am now using a drill sharpener machine and like it fine. My boss has always said that I was a good blacksmith and the steel stood up fine.

We are now starting in on a big road job and have lots of rock to drill. The drill men are breaking bits every day. I make and temper the bits the same as I always did and we are using the same rock drills and steel that we used on the last job. I can't find anything wrong. Can you tell me what might be wrong?

Yours very truly,

Philadelphia. J. H. S.

In all probability the unusual steel breakage is due to some impurity in the water which you are using for tempering.

Frequently surface water, and sometimes well water, contain salts which have an unfavorable reaction upon heated steels. We suggest that you try using rain water in your tempering tub.

It would also be a good idea to send a sample of the water and some of the broken steels to the rock drill manufacturer from whom you bought the steel. They, no doubt, will be glad to make a careful analysis and advise you regarding the proper procedure.

* * *

Compressed Air Magazine.

Dear Sirs:—I am in the contracting business doing several foundation jobs and lately we have had a lot of trouble with shanks chipping off on the striking end. I would appreciate it very greatly if you can give me any suggestions for remedying this trouble.

Denver, Col. R. M. M.

It would be necessary for us to have more information about your sharpening and drilling conditions. One of the common causes of shank breaking is the hardening of shanks in water. This tempering should always be done in a soluble quenching oil and care should be exercised that the heat should be as near 1470° F as it is possible for the blacksmith to determine. Should too high a heat be had at the time of quenching the shanks will be too hard. A simple test to determine the proper hardness of the shank is to take an ordinary file, run it over the end of the shank and if it takes hold easily the shank is of the proper toughness. If it will not take hold at all the shank is too hard.

A large German concern is paying about $2,500,000 for 30 British warships as old iron. The delivery of the ships has begun and they are to be broken up in German yards. We may assume that something more will be got out of them than mere scrap. It is reported also that Krupps, of Essen, are negotiating with the French Admiralty for a similar purchase.

MASSACHUSETTS INDUSTRIES REPORT ON ST. LAWRENCE

SEVERAL months ago the Executive Committee of the Associated Industries of Massachusetts appointed a committee of nine members to report upon the feasibility and desirability of the St. Lawrence River Waterway project. This committee consisted of Charles R. Gow, chairman; Charles A. Andrews, F. B. Crosby, George L. Finch, S. Harold Greene, Henry I. Harriman, William P. Libby, Edgar J. Rich and A. B. Tenney.

After long and careful research this committee has made a unanimous report, which says:

"Our conclusions, reasons for which will be set forth in this statement, are:

1. That the project is feasible from an engineering standpoint.

2. That it can be constructed at a reasonable cost, considering the magnitude of the work involved.

3. That it will furnish a direct and usable water route between the ports of the Great Lakes and both foreign and domestic ocean ports.

4. That in the very near future this nation will require every possible means of transportation by water, rail, and motor, and that acordingly the St. Lawrence project will be of great assistance in reducing otherwise necessary expenditures for additions to our rail facilities, and greatly lessen the inevitable transportation crisis which will arise with a restoration of normal business and the natural growth of the country.

5. That it will give to New York and New England a very large, reliable, and cheap source of hydro-electric energy.

6. That the project is desirable for the country as a whole, and beneficial to New England."

AIRPLANE TAXIES

In connection with the air taxi services that are to be run this year to connect with the arrival and departure of liners at Southampton and Liverpool, arrangements are to be made for the ordering of these taxiplanes by wireless while the liners are still far out at sea. These wireless orders will be picked up direct by the wireless operators at the London air station, and will be in the hands of the air taxi pilots within a minute or two of being despatched from the liner. In this way a passenger arriving in Britain from overseas who wishes to be at his destination at the earliest possible moment can be sure that there is an air taxi waiting for him when his liner berths. New air taxis, to cope with the greatly increased demand expected this year, are now being built. They include two, three and four seaters, and fares will be as low as 10d. per mile per passenger.

A stone from the Culebra Cut of the Panama Canal weighing a ton and a half arrived recently by the Grace liner *Santa Teresa* and will be placed over the grave of Theodore Roosevelt at Oyster Bay.

Cutting Metals Under Water

Repairing a Broken 36-Inch Diameter Water Main Under New York Harbor by Means of the Submarine Torch and Compressed Air

By ROBERT G. SKERRETT

THE SUBMARINE torch will render comparatively easy the performance of numerous underwater operations which, without it, would be difficult if not impossible of execution.

Iron and steel structural materials can now be severed or cut rapidly when submerged by this new tool and at any depth within the physical limits of the diver.

In the repair of subaqueous water mains, gas mains, oil pipe lines and other kindred conduits, as well as in the salvage of sunken vessels and the repair of the underbodies of ships generally, the submarine torch will henceforth have a wide field of usefulness.

SIX YEARS ago, Staten Island, i. e., the Borough of Richmond of the City of New York, was linked with the Catskill Water Supply System by a submarine pipe laid under the bed of the Narrows and connecting with a distributing main on the Brooklyn shore of the harbor. Thus, Silver Lake Reservoir was joined with the watershed 120 miles away and provision made for the continual storage of about 435,000,000 gallons of potable water.

The emplacement of the so-called "Narrows Siphon" represented an engineering achievement of a novel and a noteworthy character. The 10,000-foot span of that conduit consists of units of cast-iron pipe each twelve feet in length, 36 inches in diameter, and generally one and five-eighths inches thick. Section by section the conduit was assembled on a curved skidway of steel framing and allowed to slide into a trench, excavated in the harbor bottom, as the conduit lengthened and the skidway was dragged forward by an associate floating derrick.

This procedure required that the pipe joints be flexible to facilitate assembling and the subsequent planting along the line chosen. It was equally essential that these unique joints should be tight after the conduit settled into its permanent position; and to this end an ingenious type of lead packing was devised, the last of which was forced in place by means of compressed air. Each pipe unit was formed with a bell-shaped flare at one end, the lip of which was reinforced by a tire or band of wrought iron, and at the spigot or smaller end there were several annular ridges to assist in anchoring the metal packing interposed there between the spigot and the bell of the succeeding overlapping pipe section.

Before a length of pipe was submerged, the newly-made joint was deliberately deflected five degrees and tested under a hydrostatic pressure of 100 pounds per square inch. If this test was satisfactory, then that unit of the conduit was launched from the scow and allowed to sink below the harbor's surface. These details are mentioned here to show the care and the steps taken in assembling and in laying the Narrows Siphon in order that the reader may realize the limitations and the difficulties entailed in making repairs calling for the replacement of a damaged pipe section.

On February 2nd, a large dredge, operating in the slip where the submarine main is buried close to the Staten Island shore, accidentally dropped a great anchoring spud down on to one of the pipe lengths. Despite the fact that the blow of this descending spar was tempered by the penetration of 23 feet of mud, still the impact was sufficient to open up a wide longitudinal fracture a number of feet long. Instantly a geyser of water shot upward under a head of more than 200 feet; and with all possible dispatch the valves at both ends of the siphon were closed for the double purpose of shutting off the supply at the Brooklyn end and to prevent the backward flow of water from Silver Lake. Staten Island was thus isolated from the Catskill aqueduct, and its citizens compelled to rely upon the water stored in the local reservoir.

The situation called for all practicable speed in effecting the insertion of a new section; and it was equally important that none of the neighboring sound units of the conduit be wrecked or disturbed lest their joints be injured thereby. Here was a problem that called for unusual treatment and the nicest kind of handling; and the same firm of salvage engineers, the Merritt & Chapman Derrick & Wrecking Company, that laid the siphon originally undertook the repair work. The primary question was how to withdraw the ruptured length? Even before this could be essayed two things had to be done: first, the position of the break had to be determined accurately; and, next, a large area of overlying and enveloping mud had to be cleared away so that the divers could reach their goal and work without risk of having the harbor bed slide in on them.

A short distance inshore from the head of the slip is a hydrant, connected with the main, standing between a cut-off valve and the sea wall, and to this hydrant was attached an air pipe leading from a powerful compressor aboard one of the assembled flotilla of wrecking craft. When air was blown into the hydrant, and thence into the main, its only avenue of escape was down and outward toward the fractured section. On reaching the hole there the air was free to mount to the surface of the water and thus to indicate approximately the location of the trouble. Later on, compressed air was similarly employed to guide the divers to their tasks.

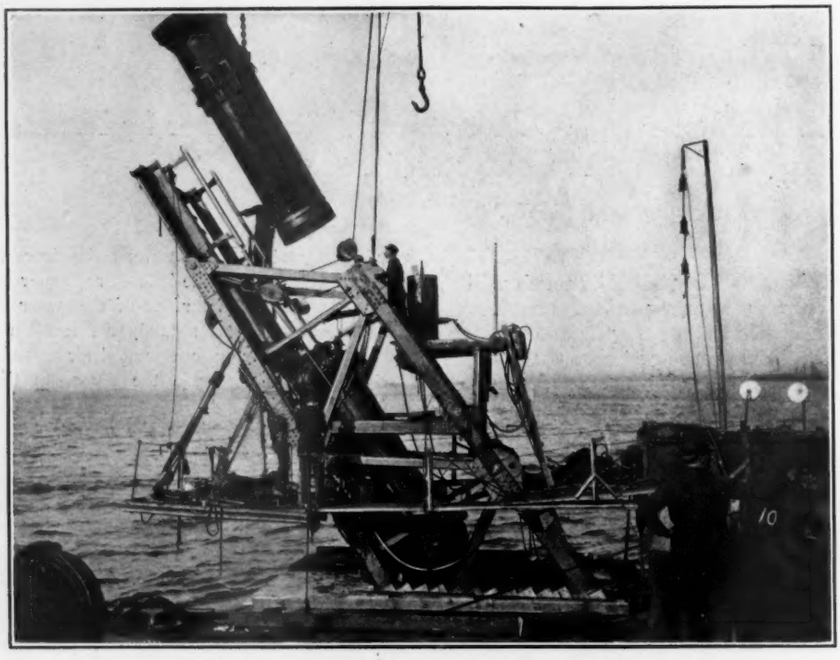
The bed of mud about the operating zone was removed by dredging and by suction pumps, and the mud immediately beneath the main was loosened up and driven out by high-pressure water jets. In this way a large crater with gently sloping sides was formed and the divers safe-guarded against a cave-in. These preparations disclosed that the damaging blow had forced downward and out of line some of the pipe lengths adjoining the broken one, and a wrecking derrick was used to raise and to restore them to alignment while the divers blocked them up from beneath. Now for the more spectacular aspect of the job.

The reports of the divers made it clear that the withdrawal of the injured section could best be accomplished by severing the bell of a joining section, just to the rear of that flare, and by cutting away the bigger part of the upper half of the smashed unit's own bell. In this way the ruptured pipe could be lifted and detached easily. To carry out this plan the salvors decided to utilize the Chapman-Kirk submarine torch perfected by one of its own experts, Ralph E. Chapman. This patented torch is the result of over three years of developmental work, in which Mr. J. R. Jenkins, the company's chief electrician, has lent valuable aid.

In its initial form, the torch consisted of an oxy-acetylene flame and an electric arc, and could be ignited under water. Further developments followed—indeed, these have been essential so as to deal with the job on the Narrows Siphon.

While the melting point of cast iron is about 2,200 degrees Fahrenheit, remelting calls for a much higher temperature, something like 3,000 degrees Fahrenheit. Therefore, the cutting of the heavy walls of the Staten Island submerged conduit presented a more difficult problem than any previously attacked. During a series of tests, preparatory to dealing with that task, it was proved conclusively that oxy-acetylene gas would not answer, especially at the depth required, where the pressure of the combustible would have to be 30 pounds or more. Acetylene at that pressure, instead of flaming in the desired manner, is apt to explode and to backfire up the pipe, bursting the latter if it does no greater damage.

True, the oxy-acetylene flame has a temperature of 3,600 degrees Fahrenheit when combustion is perfect, but under water the gas has a two-fold function to perform: first, that of

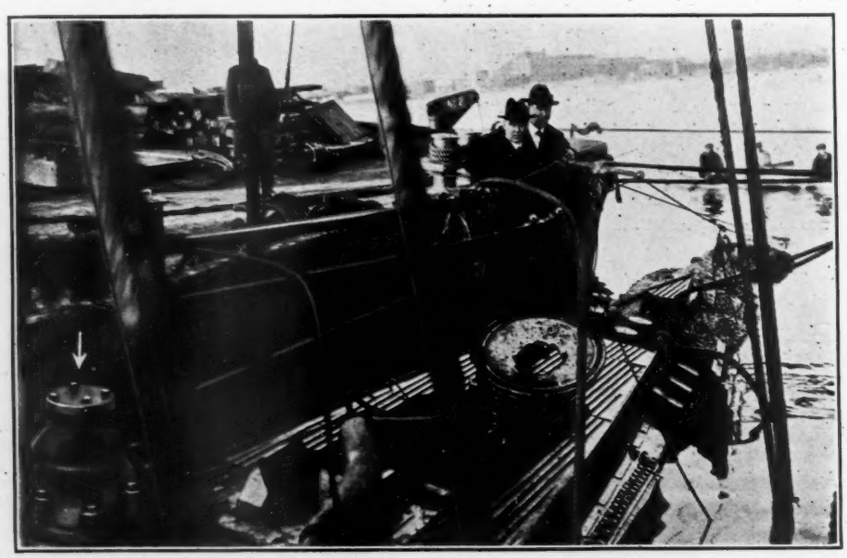


Great care was exercised in originally assembling the pipe section, packing the joints, and testing each unit before allowing it to slide under water.

holding the surrounding water at bay by reason of its expulsive force exerted within a cup-like nozzle, and, next, that of melting the metal exposed to the flame. Therefore, the repelling impulse must more than counterbalance the hydrostatic head of the enveloping water; and when the flame is not at its normal intensity its heat is too quickly dissipated to enable the torch to cut through fairly thick barriers of metal—especially such a metal as cast iron.

The torch recently employed does not rely upon oxy-acetylene, but uses another cutting gas, and this is brought into play in combination with an electric arc. The gas is drawn from flasks charged under high pressure. The inflamed gas—exerting a disruptive force by reason of its rapid expansion due to heat and its exhaust pressure—converts the surrounding water into steam, and in the midst of this vaporous envelope the incandescent arc comes into action automatically. That is to say, the diver, by holding his torch within a quarter of an inch of the metal to be attacked, induces an arc across the gap; and so long as he maintains this distance, and current is fed through the attached conductor, the electricity flows to the neighboring "ground."

The temperature of the arc is about 6,700 degrees Fahrenheit; and this intense heat has made it possible to cut through the one and five-eighths-inch wall of the conduit at a linear rate of from four to six inches per hour. This speed varies with the ease with which the diver can reach his objective. Wrought-iron or steel plating one-half inch thick can be cut at the rate of twenty inches per hour.



A submarine torch is also a very useful agency in the salvaging of ships. This shows the U. S. submarine S-48 after she was raised. At the feet of the two figures can be seen the cast-steel hatch cover and the hole cut in it by means of the submarine torch. At the extreme left, indicated by arrow, is the air-driven submergible pump used in refloating the boat.

And now let us see what was done by the divers who worked night and day so that the people of Staten Island could again have their regular supply of mountain water before the reserve in Silver Lake reservoir was exhausted. At the start, the divers enlarged a section of the break on top of the damaged pipe sufficiently to form a hatchway, through which a single diver could enter for the purpose of severing the bottom third of one bell which was not accessible from the outside. The remaining two-thirds was cut from the exterior. A large upper sector of the bell at the opposite end of the injured unit was also cut away from without. Before this latter operation was started, the shrunk-on, wrought-iron ring around the lip of this bell was detached by cutting it through at two points. This reinforcing band was an inch and a half thick and four inches wide.

When all of the cutting was finished, the slope of the circumferential cleavage allowed the pipe there to be raised right up, with the result that the lead-packed joint at the other end parted without violence so that the freed section could be brought to the surface. The replacing unit was next lowered; shifted into its proper position; secured at the bell end by gib screws; and the joint packed tight with lead wool by pneumatic hammers. Because of the removal of the bell from the sound section, as previously described, there remained a gap of about ten inches between it and the spigot of the new pipe length. To bridge this, a cast-steel sleeve five feet long, one and five-eighth inches thick, and with an internal clearance of an inch and a half, was shoved onto the replacement unit before the latter was lowered overboard. This sleeve was then shifted until it embraced equally the opposing pipe ends. It was then anchored by gib screws to each of the neighboring lengths.

The two joints thus formed were sealed in the following fashion; at each of them was inserted a split band of steel, two inches wide which was seated against the inner projections of the gib screws, and next, the remaining space, three inches deep, was packed pneumatically with lead wool. Terminal rings of cast-steel, drawn snugly against the sleeve by screw bolts, completed these joints and served to block any tendency of the metal packing to work outward.

During their operations under water, outside of the injured section, the divers used a wooden template—consisting of a central stick carrying a number of two-foot cross-pieces spaced twelve inches apart. This enabled them to determine and to report accurately the dimensions, the position, and the exact shape of the break. Even in muddy water, such as they had to contend with, the glare of the arc is rather dazzling, and although the divers tried colored glasses to protect their eyes these were not satisfactory inasmuch as they turned the feeble natural light into inky blackness the moment the arc was extinguished. This difficulty may, perhaps, be overcome by devising a screen, attached outside of the helmet, which the diver can adjust at will.

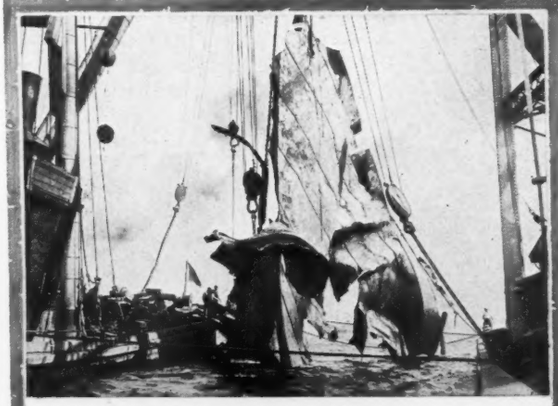
The Submarine Metal Cutting Torch and Some of Its Striking Applications

The operating outfit for submarine torches. On the right is the tank which was used for testing the torches and training the divers for the job.

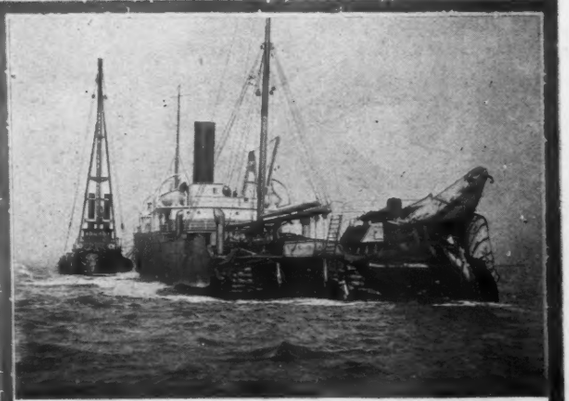
A close-up of the removed pipe section showing a diver with one of the submarine torches.

This is the way the divers worked inside of the injured main when cutting the lower section.

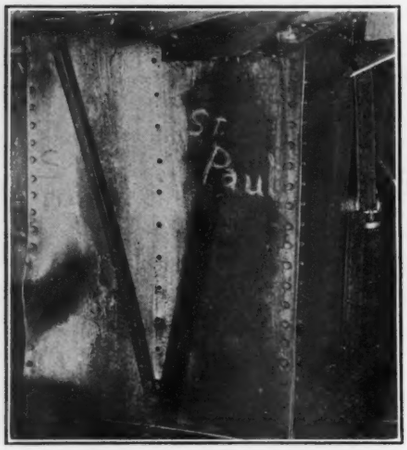
The section cut from the bell end of the fractured pipe. The thickness of the metal so severed ranged from 1¾ inches to 3½ inches.



Bringing up some of the wreckage cut from the "Lord Dufferin" by torch.



The S. S. "Lord Dufferin" after the liner "Aquitania" struck her.



The above illustration shows the steel work opened up for the passage of water by means of a blast of dynamite. Notice where the rivets have been sheared off and the plating has been bent and shattered.

The floating derrick lifting aboard the detached water-main section.

Aboard the S. S. St. Paul. At the left are J. W. Kirk and Ralph E. Chapman who devised the submarine torch used during the salvage of that liner. The circular hole, indicated by an arrow, is one of the passages cut by the underwater torch without the aid of a dynamite blast.

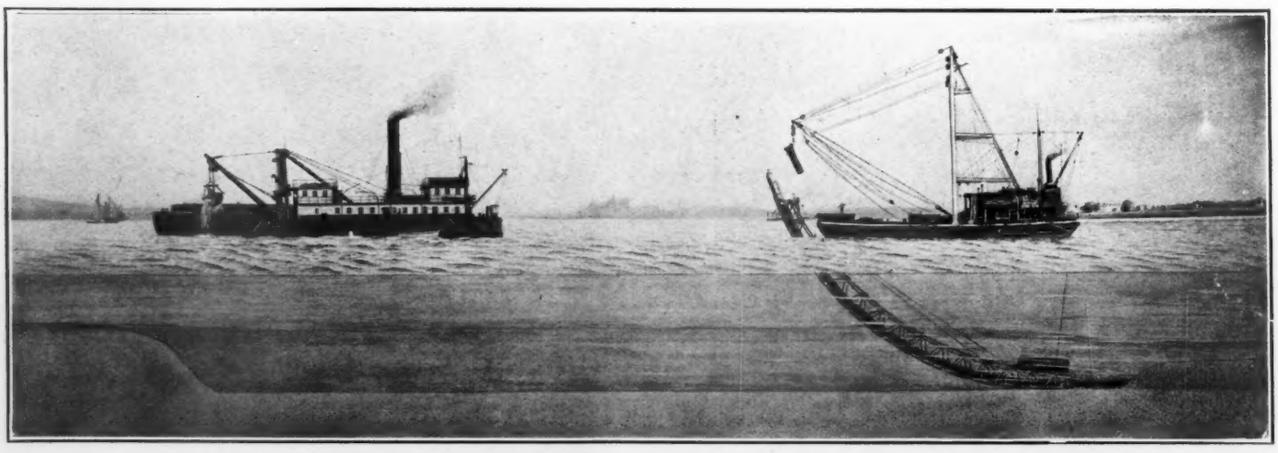
The under-water toilers are safeguarded from any untoward accidents due to their torches by shutting off the electric current while the men are approaching and leaving their subaqueous objectives. It is important that they handle their torches carefully, however, when ascending and descending, because the terminal electrodes are rather delicate; and substituting a new torch for a broken one takes time. A carbon electrode is consumed in about twenty minutes, so intense is the heat of the arc. The evolution of this apparatus and its performances indicate wide fields of service for it in the future; and this ingenious agency promises to expedite the execution of tasks under water that otherwise might be difficult if not impracticable.

When the siphon was ruptured, mud and foul water from The Narrows entered the main, and the responsible city officials recognized that the conduit should not be put in service again until it had been thoroughly purged. To effect this, after all repairs were made, the gate valve at the Brooklyn end of the line was opened, while at the Staten Island terminal the siphon was bi-passed into a neighboring sewer through a twelve-inch blow-off connection. Then, large quantities of liquid chlorine were introduced at the Brooklyn end to insure thorough sterilizing. Only after a series of tests showing the water to be in a proper state was the blow-off closed, the Staten Island gate valve opened, and the restored flow permitted to mount thence to Silver Lake reservoir.

Among many other fields of usefulness this invention promises to revolutionize present methods of salvaging sunken vessels. Last December, the U. S. Submarine "S-48," while manoeuvering in Long Island Sound, sank suddenly owing to the accidental admission of water into a tank believed to be sealed. The boat came to rest on the bottom; and it was only through the courageous efforts of the imprisoned crew that a few feet of her bow was brought above the surface. This lightening of the craft forward, which afterwards permitted the personnel to escape by way of a torpedo tube, was accomplished by shifting sternward pigs of lead ballast and by casting some of this weight overboard. The latter operation was effected through a sounding well or tube designed to facilitate the taking of soundings when the submarine was submerged. This tube had two doors, one at the top and the other at the bottom. By filling the intervening space with compressed air—the pressure corresponding to that of the outlying hydrostatic head, the lower door could be opened without admitting water, and the pieces of pig lead in the well dropped into the sea. Next, the bottom door was closed; the upper one opened; more pigs of lead placed in the tube; the top door closed; and compressed air admitted as before. This cycle went on until the craft was buoyed sufficiently.

To salvage the "S-48," the wreckers had to get into her afterbody in order to insert the suction end of a hose leading to a powerful submergible pump, which was driven by compressed air and was lashed to the deck just above the motor compartment. But before this connection could be made, divers had to cut a hole through a heavy cast-steel hatch cover, lying at a depth of 70 feet, so as to permit the hatch to be opened. Then, the divers entered the boat and closed two watertight doors in the forward and the after bulkheads of the motor-room. Subsequently, the divers sealed the open hatch with a temporary cover which had flanges on the upper and lower sides for the purpose of attaching the hose linked with the pump. The cutting of the regular hatch cover was rendered possible by an improved model of the gas-electric torch.

This experimental apparatus was used in 1918 in cutting holes through the steel bulk-



How the trench for the Narrows siphon was dredged and the conduit laid, section by section, on the waterbed.

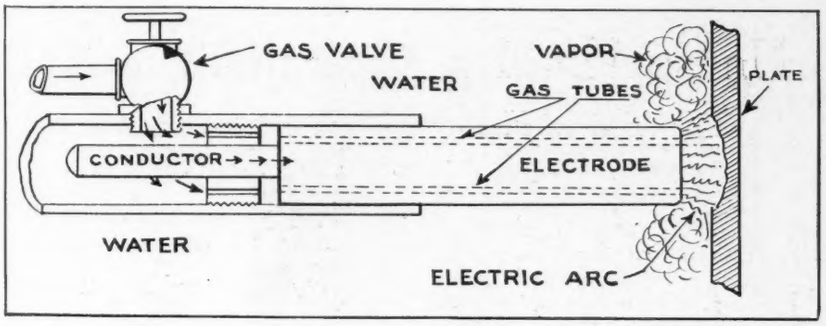
heads of the S. S. *St. Paul* while she was lying over on her side and sunk in New York harbor. These openings allowed the water to pass from one chamber into another as the ship was pumped out and the water flowed to the draining sumps. Before the torch was available the wreckers employed dynamite; and while this explosive was effective it did a good deal of unnecessary damage—adding that much more to the cost of repairs. Besides the foregoing application, the tool was utilized for another purpose in connection with that salvage undertaking.

To assist in righting the *St. Paul*, large concrete blocks had been placed in a trench dug for them in an adjoining slip and from these anchors double one and one-half-inch wires were led to the wreck. After the steamer had been raised, it was at first decided to remove both the hawsers and the concrete blocks; but, finally, it was deemed more expedient to leave the blocks in position and to cut off the hawsers level with the surrounding bottom. To this end, the under-water cutting device was resorted to; and by its aid 42 wires were severed by one diver in three days' work. The actual average cutting time was less than six minutes per hawser.

In connection with the clearing away of submerged wires, the case of the S. S. *La Perouse* is of interest, and emphasizes the value of the torch for work that frequently balks divers armed with the tools that have heretofore been at their disposal. The freighter was loading cargo in the North River when it was discovered that a hawser was fouled between her propeller and the stern guard. For days a diver ineffectually tried to remove the wire. Then the under-water cutting tool was called to the rescue, with the result that each turn of the entangling hawser was severed and quickly disposed of. The *La Perouse* was thus able to leave port, as scheduled.

On the 16th of October, 1918, the U. S. Army Transport *America* listed and sank at her pier on the waterfront of Hoboken, New Jersey. The ship was successfully floated and delivered to the military authorities a little more than a month later. In preparing for pumping operations, it was found necessary to cut drainage holes through a number of bulkheads; to cut off the large hinges on the ice box doors so as to get into the cold-storage compartments; and also to clear a hole twenty inches in diameter in order to open a way into the shaft alley. The submarine torch was used to advantage in this work, and greatly facilitated the salvage operations. The torch made it possible to do in one day a job on a three-eighths-inch plate whereas a similar task, with the usual facilities, took two expert divers five days to finish.

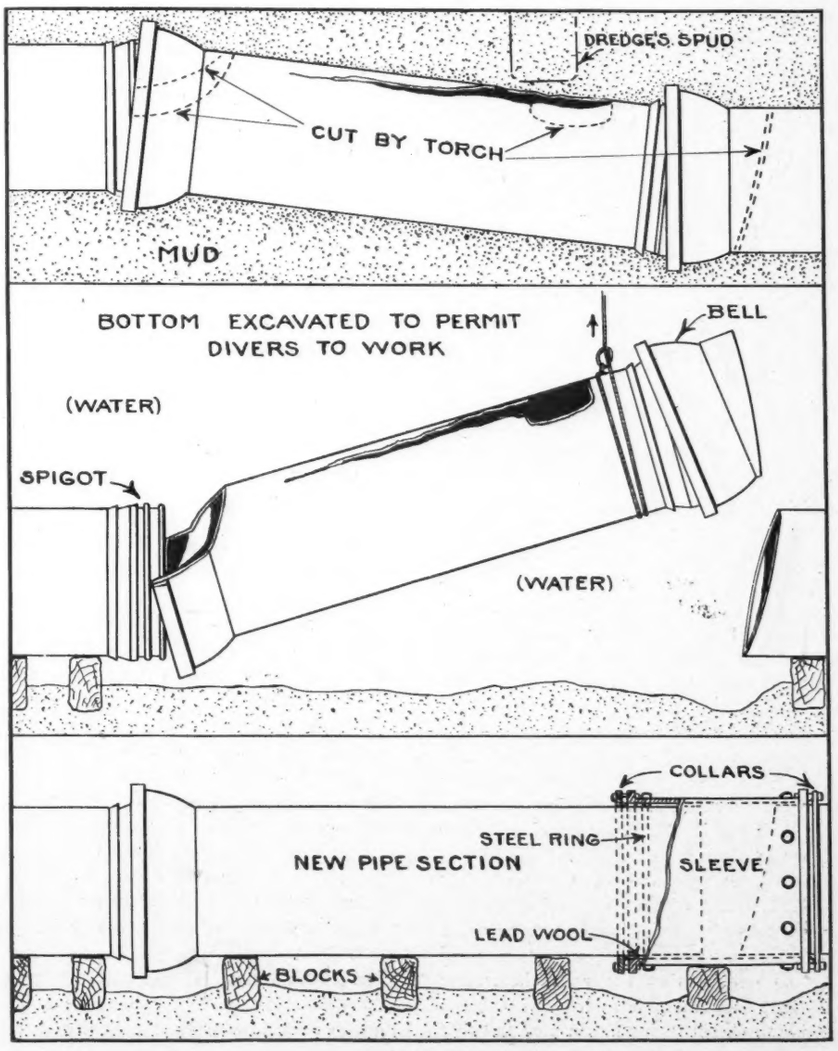
Early in 1919, the torch, but little altered, did good service in detaching some of the hull wreckage of the British freighter *Lord Dufferin*. That ship, while anchored in the port of New York, was struck by the liner *Aquitania*, which all but sliced off about 65 feet of the freighter's stern. To raise and to release the *Lord Dufferin*, preparatory to taking her into drydock for rehabilitation, it was needful to get rid of a portion of the crumpled steelwork lying under water. Dynamite could not be used without further seriously damaging the vessel. Again, the submarine torch proved its worth and succeeded in cutting free from the ship an eight-ton section of her steel plating. The plates were three-quarters of an inch thick, and where they lapped the metal was one and one-half inches through. But one diver was employed on this job which was completed in eight days each averaging four and one-half cutting hours.



Cross section of the gas-electric submarine torch.

BRICKS MAY BE BY-PRODUCT OF OIL-SHALE INDUSTRY

The experiment of making bricks from the spent shale of the oil-shale mines of Scotland is now being tried, according to *Popular Science Monthly*. The finely ground shale is mixed with a small percentage of lime, enough water being added to form a thick paste, which is then pressed into the shape of bricks and dried in steam tunnels. It is claimed that they are superior to clay bricks.



The various stages leading to the repair of the injured water main.

Unusual Drilling Operations in Anthracite Coal Region

The Modern Hammer Type of Drill Proves Indispensable in Emergencies Requiring Long Hole Drilling in Extremely Hard Coal

By C. T. CHAPMAN

SEVERAL interesting and unusual drilling operations are described in this article showing the adaptability of the modern "Jackhamer" for drilling very long holes. The accompanying diagrams illustrate the method of making joints and show how couplings were used on the hollow hexagon steel.

In one instance 67 feet of hole were drilled on a 14° pitch, and in another, 37 feet of hole were drilled vertically upward through solid rock, slate and coal.

THE AVERAGE mining man is a very ingenious person when it comes to getting out of difficulties in a short time.

The "Jackhamer" has proved itself practically indispensable to all types of operations and some very interesting feats have been performed in the anthracite coal region with the standard "Jackhamers" in times of emergencies. One of particular interest occurred a short time ago at one of the collieries of the Lehigh & Wilkes-Barre Coal Company.

On October 29th, 1921, a serious fire occurred in their Hollenback No. 2 Shaft. Practically all of the timber was burned out, pipe lines broken off, and the entire shaft gutted. In putting out the fire and also during the weeks of idleness that followed water accumulated in the shaft and in portions of the Hillman or bottom vein of coal to a depth of about 70 ft. It was impossible to lower a pump into the shaft due to the mass of rubbish and burned material accumulated at the bottom, so it was decided to drill a hole to a point at the bottom of this shaft from the Hillman vein of coal in an adjoining colliery.

They chose the point in the workings of their South Wilkes-Barre Colliery which came close to the body of water in the Hollenback working and figured that the shortest distance was about 65 ft. The vein of coal pitched slightly, and conditions were such that it would be almost impossible to even attempt to erect a diamond drill machine at the place where they had decided to drill. Drilling could not be done directly to the bottom of the shaft but it was possible to drill into a gangway about 100 ft. from the Hollenback shaft and on the same level. Work was started using a standard Class B diamond drill rod with a left hand thread instead of a right hand thread and arranged with a male thread at one end of each ten-foot section and a female thread at the other end. By screwing in a 4-ft. section of seven-eighths inch hollow hexagon "Jackhamer" steel with a four point bit, three inches in diameter on one end and a 4-ft. length of the same steel fitted with a standard "Jackhamer" shank at the other end, they started their drill. (Fig. 1). A standard BCR-430 "Jackhamer" mounted on an improvised table was used as shown in Fig. 2, and extremely good progress was made for the first 45 feet of drilling. This hole had an upward pitch of twelve degrees, and the first 45 feet were drilled in eight hours. After reaching a depth of 25 feet the male end of the drill rods began to break just at the beginning of the screw thread. Every effort was expended to make these threads so perfect that the rods themselves would butt together but it was almost impossible to obtain such an accurate joint that the rods would not break at this point. They persisted, however, in this attempt, using the diamond drill rods until the hole had gone 57 feet and hit solid rock.

It was then known by the depth of the hole that they had either hit the top or the bottom rock and that it would be useless to go further, so this hole was abandoned and another started. This second hole was drilled with a fourteen degree pitch upward and a DDR-13 "Jackhamer." The DDR machine proved too powerful for the Class B drill rods and broke the screw connections as fast as they could be put together, so the round diamond drill rods were abandoned and a set of one-inch hollow hexagon rods was made. These rods were merely sixteen-foot lengths or one-inch standard hollow hexagon "Jackhamer" steel with a small square slot or key-way cut about one inch from each end of each section. The coupling used was about six inches long and two and one-quarter inches in diameter broached to one-inch hegagon through the center, as shown in Fig. 3. A four-point three-inch diameter bit was put on the first section and a standard DDR-13 shank was put on the last four-foot section.

The first attempt was to place a coupling about a foot back of the drilling bit, with the idea that this larger coupling would have a tendency to direct the hole more accurately but it was soon found that this coupling held the cuttings just back of the bit until it stopped drilling. They accordingly changed this and put the first coupling about sixteen feet back of the bit and had no further trouble from this source.

Very good progress was made with this second hole except that when the greatest lengths of steel were used difficulty was experienced in the breaking of the steel a few inches in front of the collar on the shank end. It seemed that in forming the collar on the shank the blacksmith in heating it weakened the structure of the steel a trifle at this point, but no trouble was had with steel or couplings in the hole, and by replacing the shanks as they broke they were able to make fair progress. After drilling 67 feet solid rock was encountered in this hole but as it was estimated the hole had to reach the Hollenback workings it was charged with dynamite and blasted, hoping to break the rock at the Hollenback end of the hole and permit the water to flow out. In this they were unsuccessful as no water flowed after the blast.

Accordingly a third hole was started and drilled 65 feet with the DDR-13 and the one-inch hollow hexagon steel without striking either rock or the Hollenback workings. Beyond this point the weight of the one-inch steel resting in the nearly horizontal hole caused such a strain on the shank ends of the steel that it broke the shanks off almost every time the drill was started.

This third hole was started at a pitch of sixteen degrees upward with the idea that they would avoid hitting the rock as they had done in the other two cases. In some way which will not be explained until they are able to clean out the shaft and get into the old workings this third hole missed the gangway it was aiming for. This third hole did not break through into the gangway so a miner's hand twist drill was used with extension steels and after considerable hand work with the drill the hole was continued to a depth of 79 feet. The drillers felt certain that they were close to the gangway at this depth and charged the hole very heavily with dynamite and fired it. A steady stream of water began to flow immediately out of both No. 2 and No. 3 holes and a steady flow of about 500 gallons per minute from the two holes combined kept up for over two weeks. The water pressure observed was a little over 30 pounds at first but this of course decreased as the workings drained. The workings were completely drained so that it was now possible to reach the burned material at the bottom of the shaft and it is being cleaned up and repairs are being made.

These holes were all drilled in extremely hard coal, and sulphur streaks about one-half inch in thickness and extending for various distances throughout the vein of coal were continually encountered. These sulphur streaks are extremely hard and often had the tendency to throw the hole out of line in one direction or another. This continuous slight bending and twisting of the hole put a tremendous strain upon both the "Jackhamer" and the steel which

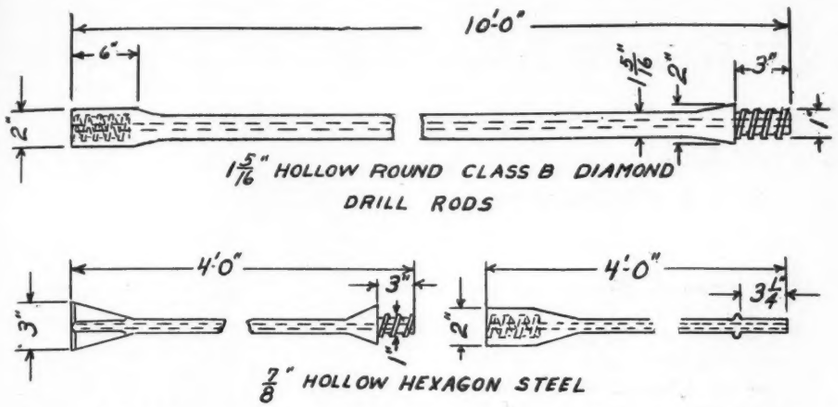


Fig. 1—Sectional steels made of ⅞-inch hollow hexagon and 1 5-16-inch hollow round steel used for drilling long flat holes in coal.

makes the actual drilling of 65 ft. and 67 ft. holes under these conditions the more remarkable.

The total height of the vein at this point was about seven feet and the holes were started in about the middle of this vein, so that the very fact that they hit top or bottom rock, whichever it might be, at 65 ft. depth would indicate that the hole had a total deflection either up or down of about three feet. In drilling all of these holes the exhaust air blown through the hollow steel was sufficient to keep the cuttings away from the bit, to a certain extent, but the construction of the drill steel couplings was such that it was almost impossible to properly clean the hole with just the foot change, 35 feet long, with standard four-point bits, three inches in diameter. The holes were drilled on a five degree pitch down and three 35-foot holes were drilled in very short time with this set of steels and an ordinary BCR "Jackhamer." It required about three hours to drill each hole and they experienced no unusual difficulties.

As was the case in the other deep holes drilled the "Jackhamer" was unable to blow the cuttings clear of the hole at the greater depths, although it was able to keep the cuttings away from the bit enough to permit satisfactory drilling. To thoroughly clean the hole out a one-half inch air pipe was used occasionally.

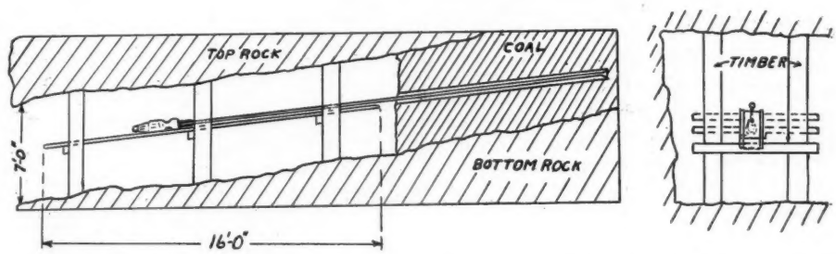


Fig. 2—A simple improvised table for mounting a standard BCR-430 "Jackhamer" drill for drilling flat holes in coal.

"Jackhamer" blowing devices after the hole had penetrated a short distance, consequently the steels were brought out of the hole and the hole blown clean by the use of a one-half inch air pipe inserted to the bottom of the hole.

This is by no means the only example of deep holes that this company has drilled. At its Buttonwood Colliery a short time ago in driving a tunnel, a bad pocket of gas was encountered and to drain this gas pocket it was decided to drill several holes from the face of the tunnel straight ahead in the direction the tunnel was being driven. They made up a special set of seven-eighths inch hollow hexagon steel, two

This same company at another one of its operations has used the standard BCR-430 "Jackhamer" and seven-eighths-inch steel, in testing for veins of coal, and in one particular instance drilled a 37-foot hole vertically upward through rock, slate and coal into another vein for test purposes. In doing this they used standard six-foot lengths of steel with standard "Jackhamer" shank on each end of each steel except the first length which had a three and one-fourth-inch diameter four-point bit on one end. As a six-foot run was made upward they slipped a six-inch piece of wrought iron pipe over the shank of the steel in the hole and inserted the shank end of another piece of steel in the same pipe collar. As the hole was drilled vertically upward and the pipe collar was swedged to seven-eighths-inch hexagon, the drillers were able to satisfactorily accomplish their work.

The various incidents noted above show the general adaptability of the standard "Jackhamers," especially in times of emergency, to be far beyond ordinary expectations.

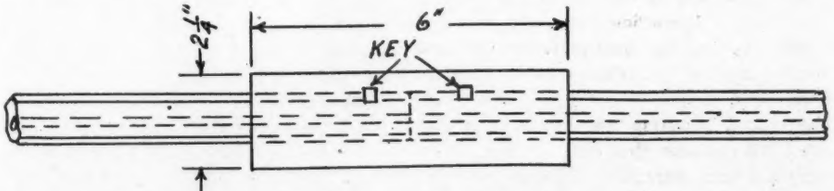


Fig. 3—Six-inch coupling, 2¼ inches in diameter, broached to a 1-inch hexagon through the center.

PERFORMS BIG CHORES IN WAREHOUSES AND ON DOCKS

It begins to look as though the captains of industry were stealing an idea from the home. The same air power that sucks the dirt out of carpets and rugs and off bare floors in the home is being used on a larger scale to do big chores in warehouses and on docks according to a recent article in the *Cleveland News*. The principle of the electric vacuum cleaner is being applied to unload coal and to handle grain and other products in large quantities.

In London air pulls the coal for one of the great power stations up tubes to a height of 65 feet and unloads it into the warehouse near by at the amazing speed of a ton a minute. This vacuum system expeditiously performs work which would otherwise require the services of a large crew of men. It is economical and efficient.

Following the great grain explosion in the Armour elevators in Chicago last summer came the problem of how to salvage millions of bushels still left in the bins. The engineers solved it by resorting to the power of this apparently thin and insignificant air which is so cheap and easy to obtain. The vacuum tubes which were let down into the mammoth bins removed the grain at the rate of 300,000 bushels per hour. Out on the San Francisco wharves, air alone is the stevedore which unloads thousands of tons of copra—the dried meat of the cocoanut which forms the basis of butter substitutes and many soaps and other products. The suction method so familiar to the modern housewife has reduced by one-third the time the ships from the Philippines must lie at the dock while this material is being taken from the holds.

It's true, of course, that air has long been known to the scientist as one of the greatest natural forces. Its hurricanes create havoc and at times even change the configuration of the earth's surface. During a recent winter a cyclone snowstorm carried more than thirteen million tons of dust and dirt from New Mexico and Arizona to Iowa, Wisconsin, Michigan and New England. Investigation proved that the residue left after the snow evaporated would amount to more than 13.5 tons per square mile.

Air brings the dust into the home, and air, in a stream generated by an electric motor, takes it out again. Someone with a penchant for figures recently calculated that in the average home 648 square feet of rug surface must be cleaned every week, making in a year a total of more than a square mile. Without the easy, sure service of electric suction, this is a sorry job for the housewife. Air is good for a lot of things besides just breathing, we are now finding out.

THA SERVICE H'ENGINEER

By D. E. A. CHARLTON

Tha days o' h'ol time minin' 'as past an' be no more,
For h'other means an' h'other ways be used to dig tha h'ore.
There bean't single jackin' or workin' with a gad,
We use a bloody h'air machine, tha bes' that can be 'ad.

Today, thee'll fin' tha 'oist-'ouse a brave an' fitty place,
With gert machines a-standin' roun' so's man can 'ardly face.
A w'ackin' big compressor is forcin' o' tha h'air,
All sorts o' gages standin' raoun' to tell w'ot pressure's there.

Tha bal, thee'll fin', is different, from collar to tha sump,
Thee'll see a different kin' o' car, a different kin' o' pump,
Small 'oists for 'oistin' timber, new ways o' dumpin' h'ore,
An' drill machines for every groun'—a dozen kin's or more.

Coorse thee wonders 'ow, m'son, these 'ere things came to be,
An' 'ow we fin's h'out 'ow they's done, 'oo tells baout they to we.
W'y, dam-me, h'its no secret—we naws w'ot h'others do
From readin' journals, books, an' such, an' findin' h'out w'ot's new.

One thing more, I'd 'ave thee naw, an' let me make h'it clear
That thee should learn to cultivate tha service h'engineer.
An' 'oo is 'ee? Thee h'asks me. W'y, dam-me, 'ee's tha chap
'Oo 'elped to put this bloody bal h'apon tha bloody map.

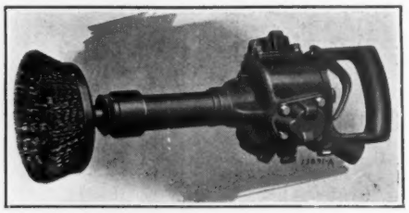
'Ee seems to naw w'ot's needed, an' tells you right straight h'out,
With 'im h'it isn't 'it or miss, 'ee naws w'ot 'ee's h'about.
So w'en 'ee comes a-geekin' aroun' tha min', jus' say
Thee'd like to naw tha latest twist—min' you, m'son, t'will pay.

THE GREATEST NATIONAL INDUSTRY

THE INDUSTRY of road building and maintenance is now apparently the largest in the United States, according to the Bureau of Public Roads, surpassing the steel and iron and the automobile industries. A few less than 600,000 are employed in the steel and iron industry, approximately 750,000 in the automobile industry; while over 1,000,000 men are employed in building and repairing the public highways. An idea of the enormous work may be obtained from the fact that the annual requirements of the improved roads of the United States is 50,000,000 tons of stone and gravel, or 1,000,000 carloads.

HIGH SPEED WIRE BRUSH FOR CLEANING

THE INCREASING use of air driven wire brushes for cleaning metal surfaces has demonstrated the need of high rotative speed for the wire brush. Especially has this been true on such cleaning work as the removing of old paint, rust, dirt and scale from tanks, steel cars, structural steel forms, etc., where the area to be cleaned was large and a fast rate



New No. 601 "Little David" wire brush cleaner.

of work was required. It has been found that a wire brush turning at high speed cleans faster and also stands up to the severe service much better than if only revolving at 2,000-3,000 r.p.m.

The Ingersoll-Rand Company, 11 Broadway, New York, have recently brought out a high speed cleaner known as the No. 601 "Little David" Wire Brush, which has a maximum speed of 4,200 r.p.m. This machine has been found very successful in operation, effectively cleaning surfaces such as mentioned above and also iron and steel castings. It has proved that it not only does a first class cleaning job but effects a considerable saving of time and labor as well.

On a six weeks test this machine cleaned steel gondolas, each averaging 540 sq. ft. surface, in 3½ hours. All steel box cars each averaging 1,400 sq. ft. surface were cleaned in 7½ hours. The brush not only removed all the rust but the old paint as well so that when repainted the cars looked practically as if new sheets had been applied.

The air motor is of the three cylinder type such as used in the "Little David" portable grinder and which has been thoroughly tested out in the severe service to which pneumatic grinders are subjected. The machine is very simple in construction, is well balanced and operates without vibration. Light weight has been attained by using an aluminum casing reinforced with cast-in steel bushings. The weight of the complete machine is only fourteen pounds. The average free speed at 90 lbs. air pressure is 4,200 r.p.m. Length over all is 17½ in. Diameter of Wire Brush six inches.

LABOR SAVING MACHINERY VS. LABOR UNIONS

IT IS interesting to note in a recent Babson Report the statement that gradual economic forces will overcome the artificial restrictions which certain labor organizations have established. This report goes on to say that in many cases new labor saving machinery and methods of operation are helping to solve the problem. Attention is called to the swarm of new inventions which have recently been applied, looking to more efficient production. Among these is mentioned "extended use of compressed air, new tools and implements, new transportation devices." "Labor saving machinery," says Babson, "never has and never will hurt the true cause of labor, but it is certain to disillusion those workers who believe that they can profit by restricting their own productiveness."

The Directors of the Mexican Chamber of Commerce of the U. S., announce the organization of said Chamber, and its incorporation under the Laws of the State of New York, following submittal to the Secretary of State, Washington, D. C. The objects of the Chamber shall be the promotion of business and economic relations between Mexico and the United States. The directorate is composed equally of citizens of both countries.

Cleaning the surface of a steel box car with a No. 601 "Little David" wire brush before car is repainted.

Alaska—Our Last Frontier

The Development of Alaska's Mineral Resources Depends Upon Transportation Facilities—Mistaken Opinion Prevails Regarding Climate

By C. KENNETH SMULLEN

THE PEOPLE of the United States know very little about Alaska and the great possibilities for development that it possesses. Increased transportation facilities have removed a great many of the hardships of earlier days, and providing the necessary supplies for men and operations has become a much simpler problem.

While Alaska's gold deposits have been exploited to some extent since the opening up of the country, the still untouched coal reserves promise to be a large factor in the mineral wealth of the territory.

Alaska is a land of much promise and will become of increasing importance as her resources become developed in a measure warranted by their extent and value.

UNIQUE IN its geographical situation, its climate and its physical beauties, Alaska, America's only remaining big out-of-doors is truly a wonder storehouse of natural resources and a veritable treasureland of scenic beauty. The average well educated American, with the possible exception of those of the Puget Sound country, is as well informed on actual conditions in Central Africa as he is on those of our own territory, Alaska.

Point Barrow, the northernmost cape of the territory, situated at approximately 71° N. latitude is warmer than any other locality so far north. The southern shores of the territory bordering on the north Pacific Ocean are warmer in the winter months than any other points of corresponding latitude. This is owing to the effect of the Japanese current.

The principal rivers, Yukon, Kuskokwim, Koyukuk, Innoko, Iditarod and Tanana, the highways of the North as they will always be are navigable for hundreds of miles. The Yukon is navigable for over 2,000 miles. The mountains including the famous peaks of Mts. Wrangell, Blackburn, Sandford, St. Elias, Katmai, Ilianna, and finally the most important, Mt. McKinley, which rises to a height of about 20,400 feet, rival those of any part of the world in scenic grandeur and impressiveness. Every type of glacier is to be found—those terminating on the ocean border or on inland rivers such as the Miles, the Childs, the Muir, the Taku and the Columbia or another distinct type which terminates in inland mountain valleys, like the Kennecott, the Spencer and the Jones.

A true appreciation of the size of this great country is necessary in order to form an adequate idea of the immense possibilities of Alaska. It has an area of 590,884 square miles equal to one-fifth of the size of the United States or twelve times that of the State of New York. The combined areas of Norway, Sweden, Finland, England, Scotland and Ireland cover 562,253 square miles, while Germany, France and Spain have a total area of 610,432 square miles.

While discussing the general physical characteristics of Alaska it should be remembered that the latitude of a country is not always an infallible guide to its climate.

Many people especially those in the eastern states have read of the inhospitable coast of Labrador, and when they find that the bulk of Alaska lies north of Labrador the conclusion is inevitable with them that conditions of life must be even worse but this is far from true.

The town of Fairbanks in Alaska, with its mines, farms, electric lights, and all of the comforts of modern life, is more than 1,500 miles north of New York City, and 300 miles north of the southern tip of Greenland.

The records of the Weather Bureau show that the average winter temperature of the ports of Prince William Sound (30° above zero) is about the same as that of St. Louis and New York, and that of Nome is similar to northern Minnesota and Dakota. As in any country of such extent, geographical features play a great part in determining climatic conditions. Chief among these, and the one which helps most to temper the effect of the far northern latitude, particularly the coastal regions, is the Japanese current which flows down the north Pacific coast.

The geographical features of Alaska divide the territory into six natural sub-divisions according to rainfall, temperature and latitude. These are best described as follows:

Southeast Alaska with a length of 300 miles by 125 miles in width, and the coastal regions as far west as Cook Inlet, are characterized by heavy rainfall and moderate temperature. The thermometer for the three winter months registers about the same as Boston and New York. In a narrow belt lying between the ocean and the Chugach mountains and extending westerly to Cook Inlet for a distance of 900 miles, the ports are open the year around to commerce.

The second region covering the southern coast of the Alaskan peninsula and the Aleutian chain of islands has a moderate rainfall and about the same temperatures as the southeastern district. Its harbors also remain open during the winter.

The region covering the entire coastal shores of Bering Sea from Bristol Bay to Point Barrow, and the coast bordering on the Arctic Ocean are characterized by wide areas of tundra and treeless plains. As might be expected, in its 2,000 miles of coast line, the rainfall and temperature vary greatly, both diminishing as we go northward. Including the snowfall the total annual precipitation ranges from 84 inches at Unalaska to only about seven inches at Point Barrow. The average is only about thirteen inches, showing that a far north latitude does not necessarily involve great depths of snow.

The Copper River Valley, protected from the heavy rains of the coast by the lofty Chugach mountains, possesses a comparatively dry climate, with colder winter conditions, and is much less thinly timbered than the southeastern section.

The Kenai-Susitna region offers a compromise between the southeastern and Copper River regions, the rainfall being moderate and the average summer temperature about 54 degrees. Much of this region is heavily timbered and contains large areas of good farming land.

The central area, containing the great valleys of the Yukon and Tanana, which are protected on the south by the lofty Alaskan range, with its extensive snow fields, is well watered, although the average precipitation ranges from only thirteen to twenty inches. The thermometer in summer climbs to 90 degrees in the shade, and the average summer temperature is about 58 degrees.

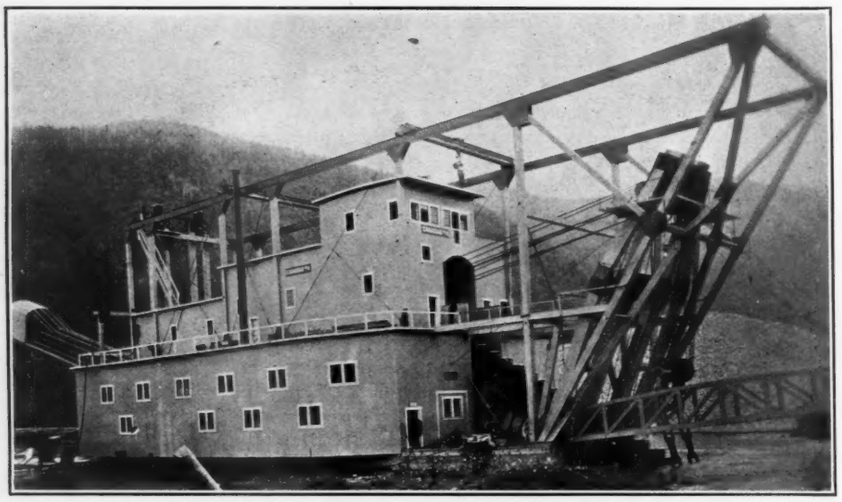
The 1920 census shows only one inhabitant to each eleven square miles, 54,899 to be exact, the white numbering a little more than half.

Norway, Sweden and Denmark lying in practically the same degree of North Latitude, have about 25 people to the square mile of area. Alaska with an equal density of population would show a census record of nearly 15,000,000 people. The present white population of Alaska is probably considerably less than the figures shown by the 1920 census, this being due to the inactivity in the mining and fishing industries. Juneau, the capital, situated a thousand miles from Seattle, has a picturesque location on the slopes of Mt. Juneau at the head of Gastineu Channel. It has been the center of probably one of the largest low-grade gold lode mining districts in the world, and in addition is the supply point for a large mineralized zone.

Cordova, the copper gateway of Alaska is the terminus of the Copper River & Northwestern railroads which extend 197 miles into the interior to the Kennecott copper mines. All ore from these rich productive mines, and all

*Acknowledgment is made by the author to the Alaska Bureau, Seattle Chamber of Commerce, and the Commercial Club for data contained in this article.

Before the dredges can operate this ground must be thawed. This is now accomplished by means of steam points gradually forced down until bed rock is reached.



A typical giant gold dredge in use in Alaska.

Three streams playing on the frozen cliffs of gold bearing gravel. The gravel hillsides of the Eldorado and Bonanzo of the Klondike region all contained gold but not enough to warrant mining operations except on a large scale such as this.

supplies which they require pass through this year round port.

Seward is a southern terminus of the Government railroad which connects Fairbanks and the interior with the coast. It is a supply point for the mineralized and farming areas of the Kenai Peninsula and also has a valuable fishing industry.

Anchorage, situated at the head of Cook inlet some 2,000 miles from Seattle, is a comparatively new town that was brought into prominence by the location there of the construction headquarters for the Government built railroad from the coast into the interior.

Nome, the gateway to the Seward Peninsula, is reached during the open season extending from approximately the middle of March to the middle of October, by steamship and is approximately 2,400 miles from Seattle. It is the trade center of northwestern Alaska, and is the supply point for a rich placer gold mining district.

Fairbanks, the queen city of the interior, and the interior terminus of the Government railroad from Seward is located in latitude 65 degrees North on the Tanana River, about 280 miles above its junction with the Yukon. It can be reached from Cordova or Valdez, by stage route over the Richardson trail, or else from Seward or Anchorage over the Government railroad. During the open season of the Yukon it can be reached by a down river trip of 1,700 miles from Skagway or else by an up river trip of 1,200 miles from St. Michaels. Fairbanks is the center and distributing point for a rich gold quartz and placer region, and being in the Tanana valley is also in a district of agricultural promise.

Mining

Mining is the industry which first brought Alaska into prominence. In general terms, productive mining on a large scale has been restricted to the gold and copper. The total production of minerals from the territory from 1867 to 1920 has been valued at slightly in excess of $460,000,000. Of this amount nearly $320,000,000 came from gold mining, $127,000,000 from copper mining, and the remainder from various products as silver, lead, platinum, tin, antimony, and tungsten.

Placer gold mining has produced about half of Alaska's gold. The rich gravels of the Nome district discovered in 1898 and the Fairbanks district located in 1902, contributed a large part of Alaska's placer gold yield. Other famous placer camps of the past were, the Rampart district (1898), Hot Springs (1899), Chandlar (1899), the Koyukuk (the first records of which date back to 1890), the Innoko (1906) and the Iditarod (1907).

The 1920 production of the gold placer mines was $3,600,000, of which the Seward Peninsula (Nome district) yielded $1,240,000. The Yukon basin district produced $1,725,000, while from miscellaneous areas came $665,000. In 1920, 22 gold dredges operated in Alaska, seventeen on the Seward Peninsula, two in the Iditarod district, two in the Fairbanks district, and one in the Circle district.

Gold Lode Mining

In 1921 the gold lode production in Alaska was limited to four general mining districts: the Juneau-Chicagof district, the Willow-Creek district, the Fairbanks district and the Nixon Forks-Kuskokwim district. The Juneau district has been the seat of some of the largest low-grade gold lode mining operations in the world. The low-grade operations in and around Juneau today are only a sad reminder of the great industry there in the past. In 1917 three producing mines of the Alaska Treadwell Co. were flooded, thereby practically stopping the output from the wonderfully productive Treadwell group.

In June, 1921, the Alaska Gastineau Gold Mining Co. closed down its mine at Perseverance and the mill at Thane. Some idea of the size of this property and of the loss its closing meant to the Juneau district, may be estimated when we consider that the average daily production of this mine was 8,000 tons; the maximum monthly production put through the Thane mill was approximately 332,000 tons, while the maximum daily production amounted to a little more than 12,000 tons. There are at present three producing gold mines operating in the Juneau district: The Alaska Juneau mine, the Ready Bullion mine and the Chicagof mine.

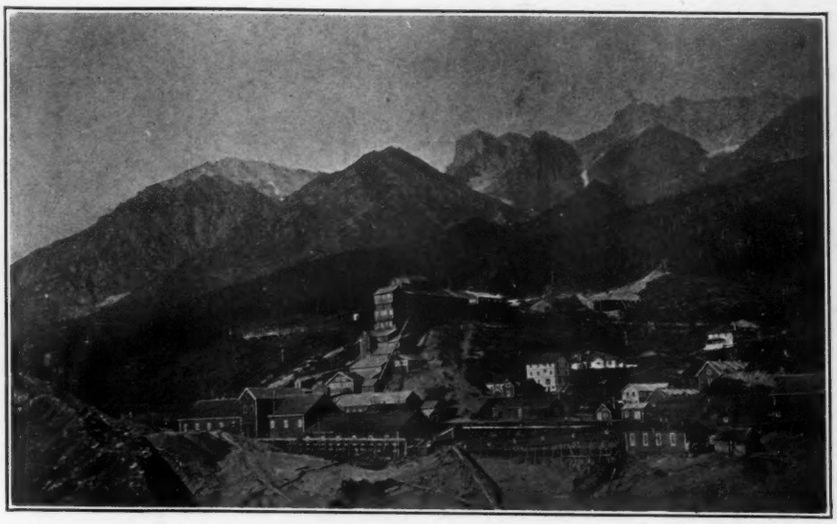
The Alaska Juneau mine is located in Silver Bow Basin approximately two miles due east of Juneau and is reached from town by wagon road via Gold Creek. The Alaska Juneau mill is located adjacent to the town site of Juneau in Gastineau Channel and is connected with the mine by a double track railway approximately two miles in length. The portal of the main tunnel to the mine is situated in Last Chance Basin on Gold Creek approximately one mile from Juneau. At this portal are repair shops, compressor power plant, a well equipped bunk house and a boarding house designed to accommodate 200 men.

This mine produces mostly gold with some silver and lead. Concentrates from the mill are shipped to the Bunker Hill Smelter at Kellogg, Idaho.

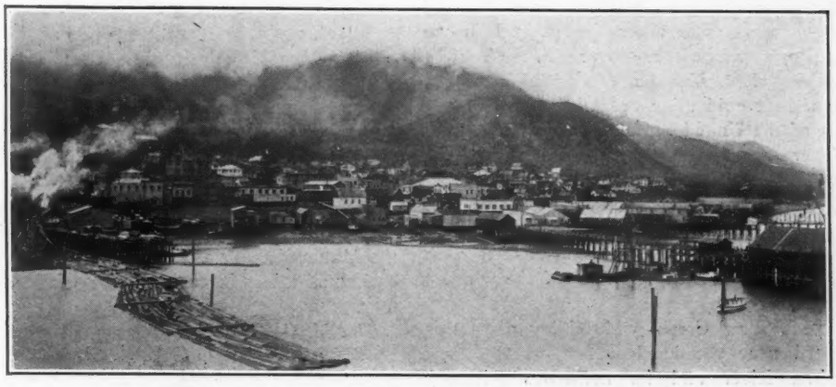
The tonnage produced in the past has amounted to approximately 2,000 tons per day. Recent changes in the flow sheet and design of the mill itself have resulted in increasing the capacity to approximately 7,000 tons per day. The mine is operated throughout the year.

The Ready Bullion mine is the last surviving member of that famous Treadwell group and is located on the east shore of the Douglas Island about three miles south of the city of Juneau. The ore from the mine yields free gold and concentrates which are treated locally at the Treadwell cyanide plant. The output of the mine is approximately 800 tons per day. Mining at the Ready Bullion at present is almost entirely confined to drawing ore from the filled stopes, there being very little new development work done. The mine operates throughout the year.

The Chicagof mine is located on the west coast of Chicagof Island approximately 150 miles from Juneau, by water. Boat service between Juneau and Chicagof is maintained on a



Mill of the Kennecott Copper Corporation which handles ore from the Jumbo, Bonanza and Mother Lode mine. Mines are located in the background about 3,500 feet above the town.



Treadwell City on Douglas Island across Gastineau Channel from Juneau. The Treadwell mine was one of the largest low grade gold bearing properties in the world. It was scarcely a mine, the ore body being 300 feet in width and running for a considerable distance along the shore.

Looking across the vein in the Treadwell mine. This was known as the Glory Hole.

Lane along the shore of the beach at Sitka leading out to Indian River and the big totems. Like many other spots of similar character, it was called "Lovers Lane."

weekly schedule thus providing ample facilities for handling freight and passengers between these points.

The Chicagof mine produces free gold and concentrates. The latter are shipped in the company's own boats and barges to the Tacoma Smelting Co. at Tacoma, Wash. It is probably the richest gold mine operating today in any part of the United States.

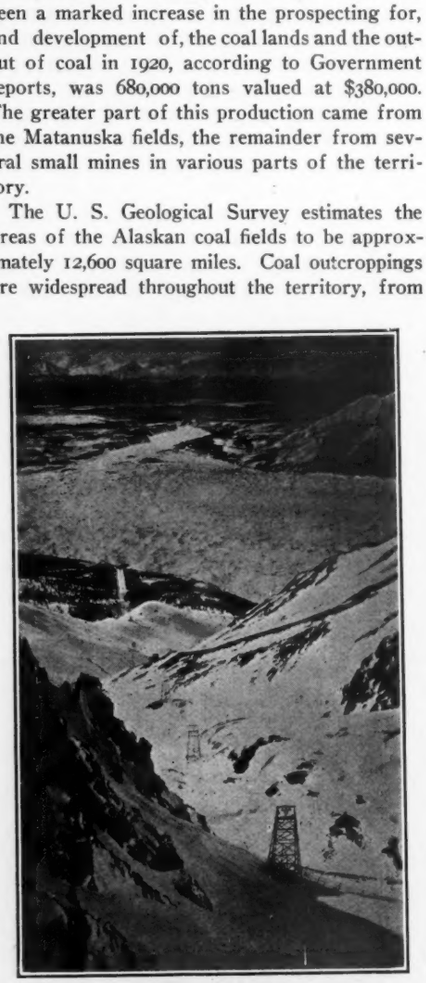
There are two stamp mills adjacent to the mine. At the property also are bunk houses, a boarding house, club rooms, modern concrete dry house with baths, and a general mechandise store and post office. Communication with Juneau is maintained by means of the wireless telegraph.

The Willow Creek gold mining district is located near the head waters of the little Susitna River and its numerous tributary creeks, and is about 50 miles distant from the town of Anchorage. Mining has been carried on in a desultory fashion for probably the past ten or fifteen years. To date mining operations have been confined to the summer season, roughly, from May until October, and though considerable values have been taken from the camp no large steady producing mine has yet been operated.

As a gold lode mining camp the Fairbanks district is still very young. Prospecting in the many valleys of this area for placer gravels disclosed a number of gold quartz outcrops, and when activity in the placer camps decreased many miners turned to prospecting and development of the quartz lodes. Development and mining with possibly one or two exceptions practically ceased during the war, on account of the combination of high prices for wages and mining commodities plus the high transportation charges. The coming of the Government railroad into the Fairbanks districts means a cheapening of freight rates on commodities and also on mining supplies. Up to the present it must be remembered that the principal route for freighting material to this district has been via the Yukon and Tanana Rivers, which are navigable only from June until October.

The first record of productive mining for copper in Alaska was made in 1900 when 3,933 pounds of copper with a value of $826 was produced. Since that time this industry has had a tremendous growth, reaching a maximum in 1916 when 119,854,839 pounds of copper, with a total value of $29,484,291, were produced. The mining of coal in Alaska cannot yet be said to have reached the point where it can be classed as a permanent industry. Since 1918 there has been a marked increase in the prospecting for, and development of, the coal lands and the output of coal in 1920, according to Government reports, was 680,000 tons valued at $380,000. The greater part of this production came from the Matanuska fields, the remainder from several small mines in various parts of the territory.

The U. S. Geological Survey estimates the areas of the Alaskan coal fields to be approximately 12,600 square miles. Coal outcroppings are widespread throughout the territory, from the Pacific to the Arctic coasts. The deposits of high grade character on which most of its recent developments have been made, are those of the Bering River and Controller Bay districts, and those of the Matanuska fields. In the lignite fields small scale productive mining has been carried on in the Nennena district and in the Bluff Point district of the Kenai Peninsula.



Looking down the Jumbo mine tramway leading to the mill at Kennecott. The white sheet in the background is the Kennecott glacier.

In the Matanuska field the Eska Creek mines are operated by the Alaskan Engineering Commission to supply coal for the railroad and other Government uses. In the Chickaloon district of this field the Alaskan Naval Coal Commission have done and are doing considerable development work to determine the suitability of this area for a naval coal base. In their operations the main purpose is the blocking out of coal reserves and not at present the actual mining of coal.

Due to the excellent coöperation of the U. S. Department of Agriculture with the pioneer homesteader it has been demonstrated that in all the valleys of southern and central Alaska the hardier vegetables of the northern latitudes can be raised. In the interior valleys wheat, barley, rye, and oats have been successfully produced. Alaskan agricultural products include: White potatoes, turnips, cabbage, celery, cauliflower, several varieties of grains and strawberries. In considering the possibilities of agriculture as a territorial industry one must remember that the growth of farming will depend on the extent of the adjacent local markets, for as yet in view of the high transportation costs the Alaskan farmer, with possibly one or two exceptions, cannot find a profitable outlet for his products in the "outside" markets.

In this article it has been impossible to do more than merely outline the extent of the resources of America's great wonder storehouse. The pressing need of Alaska today is the awakening of the American public to the fact that in this territory they have a tremendous country the resources of which they know little, and about which they should become better acquainted. The territory has an appeal for each and every American. To the sportsman it offers game, hunting and fishing of many and varied kinds. To the traveler it will give scenic beauties which rival those of any part of the world. To the business man it will represent an investment possibility which to date has yielded over a billion dollars compared with its purchase price of only $7,200,000.

Surely, a land of so many and varied resources deserves the interest and attention of every American citizen, and only by getting this interest and attention can the wealth of the territory be unlocked.

The Direct Separator Co. has recently issued an interesting booklet describing their Sweet separators for compressed air and steam lines. The need for removing moisture from the air lines supplying sand blast outfits, vibrators, etc., is particularly stressed. A pamphlet giving the results of a test of a Sweet steam separator at the Eliza Furnace, Pittsburgh, has also been published by this company.

Increasing Use of Compressed Air in Coal Mining

A Review of Modern Developments Brought About by the Introduction of Mining Machinery. Some of the Most Efficient Air-Driven Machines Enumerated and their Functions Explained

By RICHARD HOADLEY TINGLEY

THE BEST of authorities tell us that Dame Nature placed at the disposal of man in the United States a supply of coal equal to about 3,838.6 billion tons, of which 19.6 billions are anthracite, 1,955½ billions are bituminous, and 1,863½ billions are of sub-bituminous grade, brown coal or lignite. The used coal in the United States amounts to about 14.6 billion tons. In addition to the above, Alaska has also, it is estimated, nineteen million tons.

At the present rate of consumption this supply should last approximately 5,000 years, but, as populations increase, as they no doubt will, and as per capita consumption also increases, this estimate of time may be altogether too long. On the other hand, should Germany come into the market with a synthetic coal which current reports say her chemists have discovered, our coal fields are likely to fall into a state of complete neglect. This contingency, however, is not yet to be taken seriously.

Although the use of coal as a fuel has been known from most ancient times as frequent Biblical and other classic references testify, the development of its general use has been extremely slow and it is only within comparatively modern times that anything like systematic and scientific mining has been undertaken. On an almost infinitesimal scale anthracite coal was mined and shipped from the Pennsylvania fields in the latter part of the Eighteenth Century, but it is less than a hundred years ago that serious coal mining was attempted on anything like a large scale. It was the invention, perfection and introduction of modern prime-moving and other machinery that furnished the impetus for the enormous development in coal mining—a development that has all taken place, practically, since the middle of the last century; first by the use of machines driven by compressed air, and later by a combination of compressed air and electricity.

Machinery Steps In

While in 1850 practically all mining operations were done by hand, it is now estimated that fully 56 per cent. of all coal mine labor is done by machinery. In one way or another electrical energy now drives from 90 to 95 per cent. of all mine machines including air compressors. Since but this relatively small per cent. of mine work is now done by machinery, it suggests that there is still room for a wide development, not only in the equipment of many small mines which still operate largely by hand labor, but in the invention, application and introduction of new and improved labor saving and economic devices. The field is wide and offers broad possibilities and, if the progress made in the last 50 years is to be duplicated, the economic problem of coal mining and handling will be in a fair way of reaching perfection.

ENORMOUS advantages have been gained by the coal mining industry through the introduction of mechanical equipment.

Although the introduction of this mechanical equipment has resulted in materially lowering the cost of production, the United States still finds itself no less than two dollars a ton above the price of British coal in Mediterranean markets.

Many difficult problems involving the welfare of the whole American people as well as the future of our export coal trade center around this factor of production cost and it is receiving the serious attention of every operator.

No industry is more important to the health, happiness and prosperity of a nation than the production and distribution of its coal supplies.

As is no more than natural, the difficulties and costs attending the mining of coal will increase as years go by and as we continue to take 600 or 700 million tons from the ground each year. Up to the present time it has been the easiest and most cheaply handled coal that has been mined—becoming more difficult and expensive as the work has progressed—a condition which is sure to become more and more accentuated as operations extend farther and farther away from the mine openings.

The Problem of the Future

The future of anthracite mining, for the next hundred years at least, will be the working out of deep-level steep-pitching veins, 2,000 to 3,000 feet beneath the surface, says Mr. Edwin Ludlow, "even with the most careful mining it will be difficult and expensive to maintain the haulage roads in these veins at that great depth, or to obtain the proper proportions of prepared sizes demanded by the market." It is apparent, therefore, that the coal mining engineer of the future faces an economic problem of no small magnitude if he would solve it successfully and keep production costs down to reasonable levels. Enormous wastes in coal mining have been going on, particularly in the bituminous fields. These wastes have principally occurred in the small mines where owners, owing perhaps, to a lack of capital and a desire to reap immediate returns, have worked more with a view to such returns than to the future of the mines. Large wastes have resulted. It is to the correction and elimination of these wasteful and unscientific practices that the mine owner and his engineer of the future must address themselves if the business of mining coal would be placed upon a footing commensurate with its importance.

Ideal Coal Mine Machine Equipped Throughout

The ideal coal mine is one mechanically equipped throughout under conditions where the working force should gradually evolve into one required primarily for the operation and maintenance of the machinery employed. It has been stated on good authority that there are many bituminous coal mines recovering as low as 50 per cent. of possible coal against a recovery as high as 95 per cent. in well conducted mines—that the bituminous coal industry employs a force of upwards of 600,000 men, and that at least 100,000 of these workmen could be dispensed with and recoveries of 90 per cent. of coal obtained by a systematic standardization of methods on modern lines in which the introduction of a greater number of machines to take the place of manual labor would play an important part.

Compressed Air Indispensable for Coal Mining

It is probable that compressed air has been a more important factor in the development of coal mining than any other single agency. It is probable, also, that it will continue to function as one of the prime aids to economic mining as long as coal continues to be mined and as improvements in its application are introduced.

Although steam is, and doubtless will continue to be the basic prime-moving power in coal mining, there are innumerable reasons which mitigate against its direct underground use. Much the same may be said of its secondary power electrically applied. Although depending upon one or the other of these agencies as a prime-mover, it has been fully demonstrated that neither of them, direct or secondary, can compete with or take the place of the functions now performed by compressed air, particularly in underground work.

"It is unfortunate for the mining industry," says Mr. H. E. Gray in *The Coal Industry*, "That compressed air was first introduced and tried in mines at a time when unscientific meth-

ods prevailed and when work requiring any degree of skill received but scant attention on the part of men who were untrained and incompetent to perform the work needed."

One of the early difficulties was the loss due to leakage of transmission lines; other objections were traced to improper installations and the employment of untrained labor. Since the early days, however, compressed air engineering has solved all of the old perplexing questions and is today preëminently suited for use in solving many of the most difficult mining problems—in fact, as Mr. Gray says, in making a careful survey of past and future coal mining and as deep mining becomes necessary, the possibilities for its successful and economic use are almost limitless and the variety of its uses rapidly increasing.

Selection of Air-Driven Machines

The problem of coal mining which now faces the owner, therefore, is one of selection of the machinery best suited to his needs. Not to deny electricity any of its dues as an efficient aid in coal mining operations for it performs a part which could not well be accomplished by means of other agencies, it cannot be gainsaid that, after an efficient system of wiring has been installed in and about the mine and current introduced, the principal machines to which attention must be given are those using air compressed through the electrical agency.

In order to follow through with an enumeration and description of the air-driven devices which modern methods and inventions have placed at the disposal of the coal miner, and to illustrate the uses of these machines in their particular provinces, the subject naturally divides itself into two parts: development and production.

Development; Core Drills

The air-driven machinery at the disposal of the prospector or developer is, largely, designed for surface operations and for boring for prospecting purposes underground. One of the first of such machines is the core drill, the principal function of which is the determination of the character, order, thickness and extent of the materials beneath the earth's surface by means of cylindrical cores which it extracts. This drill is designed for the express purpose of

Courtesy Coal Age.

Sprinkler car operated by compressed air used for laying dust in coal mines.

"Taking the guess out of mining." There are two types of core drills now in practical operation; the diamond drill and the diamondless drill. The former uses black diamonds or carbons set in a bit, and the diamondless employs either a steel cutter or a bit with a chilled shot or crushed steel as a cutting agent. The latter is the more recent invention and, in addition to performing all the work which the older diamond drill can do, it is capable of extracting cores of such size that the cost of carbons for diamond drills would be almost prohibitive. It is claimed, also, that the cost of drilling, foot for foot, is less by the newer method than with the diamond drill.

Successful diamondless borings have been going on the world over for years, and their utility has been established beyond question. A 1,400-foot bore has recently disclosed to a coal prospector in Colorado five inch samples for the entire distance; similar borings in Wyoming, West Virginia and other states have brought reliable cores to the surface clearly indicating the depth, extent and pitch of the veins as well as of the interlying formations. Diamondless drills will extract cores as large as nineteen inches in diameter, the power required for their operation depending on the size and depth.

It will be difficult, however, for the diamondless drill to match some of the performances of its competitor, the diamond, among which the latter holds a record, according to Mr. William J. Nocolls, of drilling a core near Parnschowitz, Silesia, 2,170 yards deep, in 1892, passing through and bringing to the surface 83 separate samples of coal from different levels.

Both the diamond and the diamondless drills have their place in the mining field and it is held by many users that the older machine is at its best in competition with the newcomer when drilling through very hard rock, whereas the older type finds its greatest competition in the larger diameter holes and in boring through broken formations.

Mounted and Unmounted Drills

For shaft sinking, tunnel driving and entries, both mounted and unmounted air-driven drills are used. The so-called mounted drills are a more powerful type, reliable and efficient where heavy open work is to be done. Of unmounted drills there are an endless variety from which the prospector may make selection and in the ditching, sump sinking, track ballasting, hauling, stripping and auger hole drilling necessary in development work, air-driven machinery supplies a tool for every operation.

Varied Use for "Jackhamers."

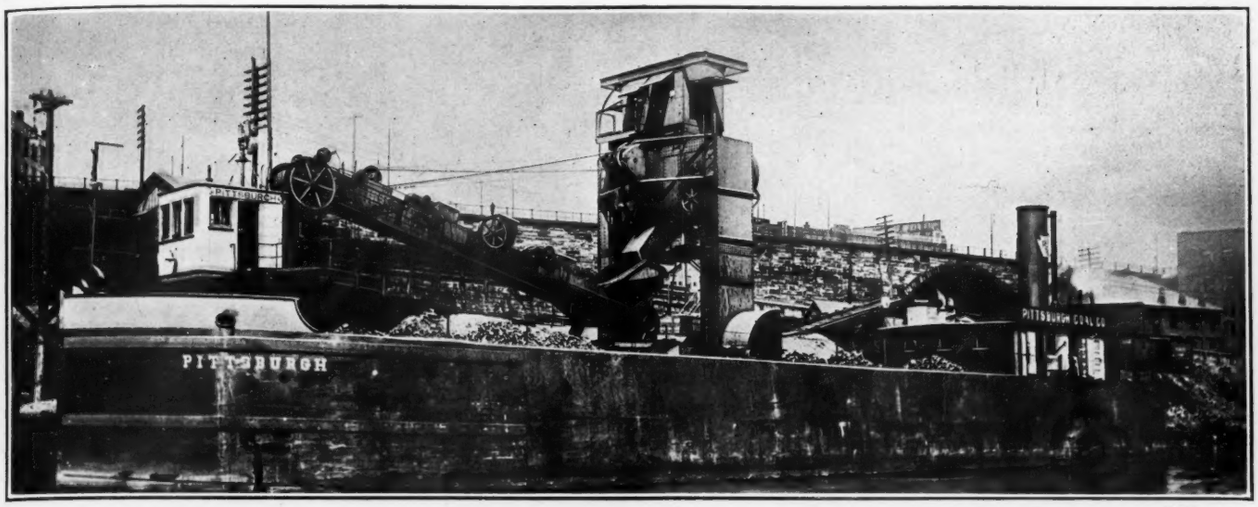
Perhaps the most efficient modern air-tool at the disposal of the miner and one capable of more and varied uses than any single machine in mining is the "Jackhamer." In shaft sinking in a Pennsylvania mine 4,760 feet of hole were drilled in seventeen days, and in a Tennessee mine a 7x14-ft. shaft was sunk 24½ feet in six days of nine hour shifts. Such performances are of every day occurrence. In a Kentucky operation a comparison of "Jackhamer" work was made with that of hand drilling; it took two men with hammer and steel one entire day to drill nine holes six feet deep, while alongside a "Jackhamer" did the same amount of work in fifteen minutes. The "Jackhamer," in its many sizes and types, is now of almost universal application both in coal mining and elsewhere.

At mines, electrically operated, compressed air for drilling is obtained by the aid of portable compressors. The air drill is light in weight and can be easily handled by one man, and as it is self-rotating it greatly lessens fatigue. "Jackhamers" are used successfully for drilling in hard coal as well as in soft, and are particularly advantageous in low seams where lightness combined with portability is required.

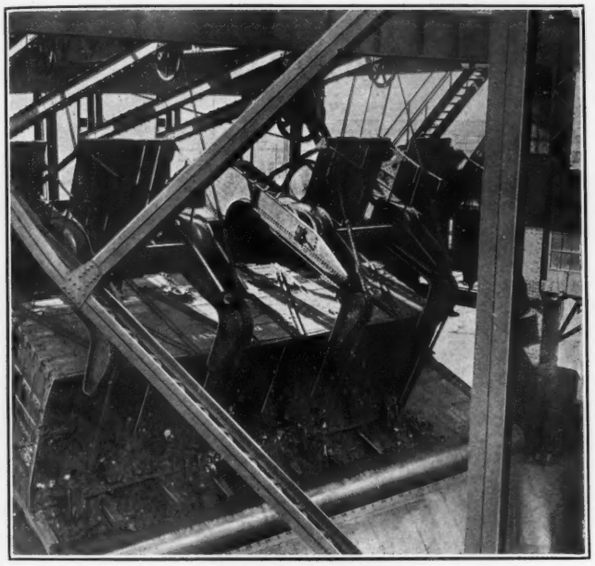
This modern hammer type of drill is used for shaft sinking, stoping, tunnel trimming and drifting, cutting channels in roof, bench work, cutting sumps, sinking winzes and many other mining operations. Hand methods of drilling are slow and expensive when compared with the fast drilling speed of the "Jackhamer" drill.

Another very important application is for breaking up boulders and ledges by block-holing. Formerly, practically all boulders were broken by placing dynamite on the surface o

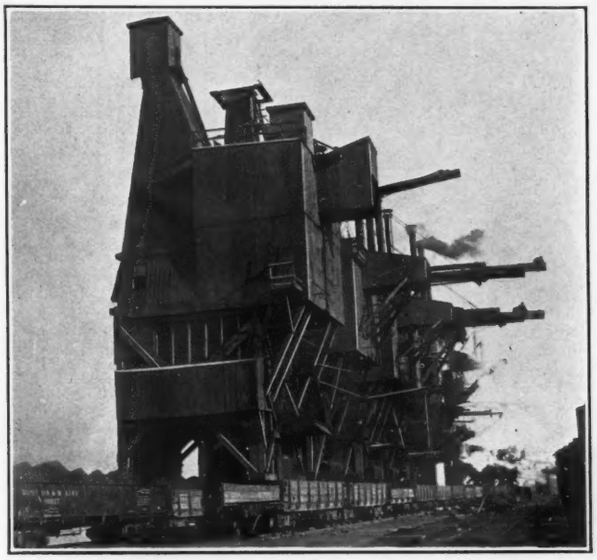
Using a coal puncher to break out rooms in an entry.



The largest and best equipped vessel of its kind on the Great Lakes. A lighter which handles coal in the harbor at Cleveland, Ohio.



Railroad car being emptied by the dumping machine of the B. & O. R. R. on the Baltimore waterfront.



Huge coal unloading machinery installed at the Boston and Maine railroad yard at Mystic Wharf, on the Mystic River, Charleston, Mass.

Electric motor pushing a "gon" up to the platform of a big hoist which picks up the car and dumps it through the chute into the hold of the ship.

Photos © Galloway, N. Y.

A big steamer taking on a cargo of coal at a Hocking Valley R. R. pier, Toledo, Ohio. Steamer brings ore from northwest and takes back coal.

the rock without drilling. This method involved the use of five or six sticks of dynamite, whereas by drilling shallow holes with "Jackhamers" a half stick accomplishes the same result. In these days of the high cost of powder this saving cannot be overlooked. As stated above, certain types operate on both steam and air, and this feature makes these machines indispensable for use with a steam shovel. If the shovel is not equipped with an auxiliary air compressor the "Jackhamer" may be hose or pipe-connected to the shovel boiler. The substitution of "Jackhamers" for former hand methods has been coincident with the increased application of open-pit mining.

Particularly do coal mines find that the "Jackhamer" equipped with spiral or auger steels drills eight to ten times faster than the old style hand auger for boring coal. Not only is it used for getting out the coal, but also for picking out the rock, dirt and clay bands and for driving entries and gangways.

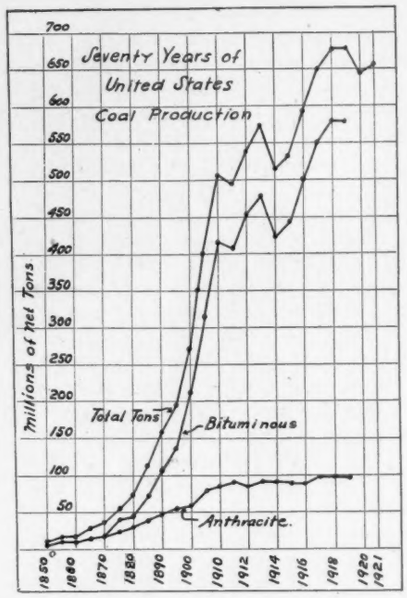
Drill Steel Sharpener Operated by Compressed Air

The advent of the sharpening machine, together with a better grade of drill steel, made it possible to utilize the full benefit of the rock drill as then built. It also made possible the development of faster drilling and lighter machines.

The rock drilling machine has always been far in advance of the drill steel and the bit. The compressed air sharpener has helped to bridge this widening gap. Its success was demonstrated by its very early adoption by the world's largest mines.

In most steel sharpening shops one or more are at work. In 1920 one large American coal mining company had 44 of the largest "Leyner" sharpeners.

The many advantages of properly formed and sharpened drill bits—among which are increased drilling speed, reduced drill and steel breakage, ease of operation, and lower sharpening costs, all resulting in the increased efficiency of the rock drilling plant—are now universally recognized. No mine operator using three or more rock drills can afford to be without a drill steel sharpening machine.



Hand sharpening is, at best, expensive and unsatisfactory because the accuracy and the quality required in a good bit are never attained by using this method.

While rapidity of sharpening is a valuable and necessary feature it is secondary to the capacity of the machine to produce perfect bits which have correctly formed cutting edges with sharp corners, insuring durability and large cutting capacity, and which have correct gauging, so that succeeding steels will follow without binding, thus relieving the drilling machine of unnecessary torsional strains in rotating the drill steel and severe shock resulting from striking dull steel.

One of the principal factors upon which the efficiency of a rock drilling plant depends is a correctly designed, properly made drill steel bit. No matter how efficient the compressing plant, the mining method, and the rock drills, or how careful the operator, if the bit is dull or of incorrect shape, the rock is not cut, expensive energy is wasted, and money and time are lost.

Leyner drill steel sharpening machines installed underground.

Coal Cutters

In the operation of the coal mine for production the economic field for the use of air-driven machines is limitless and modern ingenuity has produced a machine to fill every want. It has supplied every variety of coal cutter and has almost altogether done away with the laborious practice of hand cutting. This has resulted in a larger output per man; larger tonnage available from a given face; more rapid advance of the face and hence better roof control; a larger percentage of coal of desirable sizes; an aid to ventilation due to straight line faces; better division of labor obtainable because one man has but a single job to do and does it. It has resulted also, in a large saving in explosives required. Of the types of coal cutters in use the disc seems the favorite in longwall work. Other types are the bar, the chain cutter and the percussion machines. This latter differs from the other types in that, instead of the undercutting being done by a continuous tearing action, the coal is bored by a rapid series of powerful blows struck by a reciprocating bit.

Pick Machine

A pick machine or puncher, operating by compressed air, is also employed and does the work of six to fifteen skilled pick miners in undercutting. Its greatest field is in horizontal seams. But it is also adapted for undercutting in pitching seams, the angle of which does not exceed ten, or occasionally fifteen, degrees from the horizontal.

While varying local conditions forbid any definite statement of the work which a coal mining machine will do, it can be stated as a fact, based on the widest experience, that the pick machine has a marked advantage over hand mining on the following grounds: lower mining cost, due to the fact that the greater cutting capacity of the machine will maintain a given output with a lower labor cost, or a greater output with a given labor cost, even when interest, depreciation, "differentials" and operating costs are charged against the machine; improved quality of the output, brought about by the deeper and more uniform undercut of the machine, which increases the percentage of lump coal ten to twenty-five per cent. over hand mining methods; more rapid development, due to the much greater speed with which entries can be driven by the machine; reduced number of working places for a given daily output; greater safety, because the deep machine undercut permits more coal to be brought down with a smaller powder charge, reducing the danger from the explosions attendant upon a "blown-out" shot.

Other advantages incidental to the use of the air puncher are that the miner is never exposed to a fall of coal in undercutting; improved labor conditions, as the miner is freed from much disagreeable work, and can get a larger tonnage with a machine than by hand; improved ventilation by the exhaust air; the possibility of furnishing air to entombed miners, in case of accident, or of delivering water through the air pipes to the coal faces in case of fire.

It is unnecessary to enter here into a discussion of these several points. The hundreds of

mines in every part of the country in which these facts have been demonstrated are the best argument in favor of machine mining as against hand methods. There are single instances where mines are using more than 500 punchers, and hundreds of mines using from five to 50 of these machines. This is conclusive proof of their legitimate claim to superiority. For seams of greater pitch than fifteen degrees, a special coal cutting machine has been designed which operates in coal seams up to a pitch of 55° from the horizontal.

Its successful operation in some coal seams practically flat or of but small slope, has clearly proven that its field of usefulness is by no means limited to sloping seams.

Mounted upon its vertical column centrally placed at the coal face, this machine is good for cutting, at one set up, a room whose maximum width may reach 25 ft., and whose depth of coal undercut may reach a maximum of nine feet. In ordinary mining operations, however, the width of room cut averages about sixteen to twenty feet while the depth of undercut averages five to six feet at one set up. The vertical height of undercut is about six and one-half inches at the face and five inches at a depth of six feet.

When mounted on a horizontal arm clamped to the vertical column, this machine is extensively used for centrally shearing a vertical cut in the coal face. In some mines where the seams are narrow, and highly sloping, and particularly if the coal is "tight," the machine is used for shearing almost entirely. In many mines it is used for both undercutting and shearing, but in most of them its use is largely confined to undercutting.

While this machine was designed for coal cutting, its rugged construction also allows its use as a rock drill for trimming or "brushing" down entry rock walls and taking off the rock on either side of the coal seam. This double use makes it particularly popular in somewhat narrow seams where the entries are continually requiring the taking up of rock bottom or "brushing" down the rock roof.

The height of the undercut above the level of the rock floor is, of course, readily adjustable. This allows the machine to be splendidly adapted to another use which improves the grade of coal product carried to the surface.

Conveying, Hauling, Hoisting and Ventilation

In the work of conveying coal throughout the mine to openings for delivery to the outside, compressed air plays a part in almost every operation and a suitable machine is ready for each movement in conveying by endless chain, endless belt, tram, shaker as well as in hoisting, pumping, ventilation and spraying to lay the dust.

By far the greater number of coal mine accidents and casualties come from inhaling the after-damp gases resulting from explosions, while very few casualties can be traced as directly the result of the shock of the explosion itself. Where mines are perfectly equipped with air lines it is possible to flood the chambers at such a time with a life-saving atmosphere—every valve becoming a life-saving station. It has also been found that air lines may be used to warn miners in distant chambers when their lives are endangered by fire or otherwise by converting them into carriers of some kind of stench—thus warning the men to make their getaway as soon as possible.

Pneumatic Tools in Shops

The machine, blacksmith and car shops at every large coal mine require the use of pneumatic tools. The amount of repair work necessary in the ordinary operation of a coal mine for riveting, reaming, chipping and grinding work makes it very advantageous to have a supply of compressed air available for operating these tools. The repair of mine cars alone is a big item. On the surface compressed air at many collieries is used for operating tool steel sharpeners, punches and presses, while in the boiler plant air is used for operating tube cleaners. In the power plant it is used for blowing out generators and motors.

Another use of compressed air that has become very general is for operating paint sprayers or brushes for painting the breakers and various other buildings.

Tie tamping by compressed air has been adopted in a number of collieries, particularly where there are large surface workings requiring long surface haulages it is economical and advantageous. At some collieries the tunnels, shafts, or slopes are situated as far as five or six miles away from the breaker and heavy locomotives are used in transporting these cars; in fact, at some places there are from fifteen to twenty miles of outside track that is in constant use. In order to keep this track in good shape it is necessary to keep a "track gang" of ten to sixteen men on the work and even with this force there are many loose ties, low joints, etc., that cause considerable interference with efficient transportation and increase working costs.

It is a difficult matter to tamp properly at points such as switches, frogs, cross-overs, etc., using an ordinary pick and bar. It is recommended that a portable two tool tie tamping equipment be placed in use and then all of the track around the mines can be taken good care of and with a consequent reduction in track maintenance costs.

The air hoist has proved to be a most efficient device in buggy mining and in drawing cars up inclines, for loading on cages, handling timber, etc. It can also be used in slushing operations for loading excavated material into mine cars. The small compressed air hoist operating a bottomless scraper is now used extensively in coal mines as well as in metal mines.

Compressed Air Versus Steam

There are several distinct advantages in the use of air as a moving factor in coal mines as against steam. The losses in air transmission are relatively small and the troublesome question of disposing of exhaust steam is entirely avoided. The heat from the steam pipes, too, would render the atmosphere in deep mines unbearable, while the constant use of air, in and out of the compressor serves as a ventilating factor, keeping up a continual motion.

Suggestion of a "Demonstration Mine"

Coal mining as an industry is being placed upon a plane of economic usefulness as rapidly as the vastness of its ramifications will permit. That there is much yet to learn, none will deny, and the suggestion has been made that, as an aid to a better understanding of the broad questions involved, the United States Bureau of Mines establish a "Demonstration Mine" for the instruction of engineers and owners in the best mining practices and in the selection of machinery adaptable to their needs. It has been argued that Uncle Sam already maintains agricultural demonstration stations, so why not the same for an industry of the importance of coal mining.

Gold dredging operations in the United States are fully described in Bull. 127, U. S. Bureau of Mines.—Bucket dredging has replaced hydraulic mining in importance in California and other states where hydraulic mining was once extensively carried on, and is by far the cheapest method of elevating gravel when mechanical methods are required and the physical conditions are suitable for dredging. Dredging costs vary greatly under the different conditions encountered.

Ingersoll-Rand Class ER mine car compressor and "Jackhamer" outfit working in the Lynch., Ky., mines of the United States Coal & Coke Co.

BORING INTO SECRETS OF HIGHWAYS

ONE HUNDRED million dollars of Federal funds will be spent during the current year in carrying out the Government's work in connection with the upbuilding of the country's roads. The several States, on their part, will subscribe even a greater sum coöperatively in bettering the public highways. Nationally and sectionally, we have come to realize how much the betterment of the routes of vehicular traffic contributes to the pleasure, the convenience, and the development of the entire community.

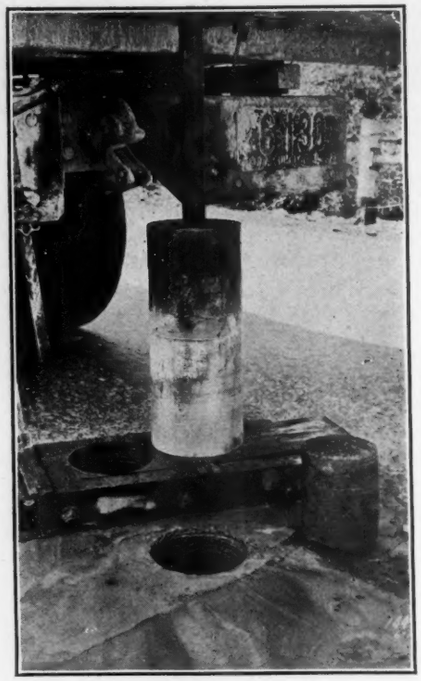
The expenditure of some hundred millions of dollars is a matter of much economic moment at any time, and especially so now when we, like most of the rest of the world, are worrying through a period of industrial and commercial readjustment. Therefore, the taxpayer naturally wonders whether this money is going to bring a commensurate return, or be lavished upon highways which will give little evidence of improvement after a few years of service.

Right here, it is possible to answer this question positively and satisfyingly. Road building is now left in the main to competent engineers who have specialized in the art; and they have at their command facilities which rob undertakings of this character of the uncertainties of other days. Not only that, there are agencies at their disposal which can check up promptly any shortcomings of a roadway which, while apparently superficially correct, may actually be defective in its underlying mass.

No other type of vehicle has laid so heavy a sponsibility upon highway engineer, as the motor truck. Where strings of plodding horses used to draw considerable burdens along the roads at a rate of possibly three miles an hour, motor trucks, with individual loads of a number of tons, now go speeding from point to point at ten or fifteen miles an hour. Their great weight and velocity do damage to roads by magnifying, so to speak, inequalities of surface that formerly were given little if any heed. Paradoxically, the road that is smooth to the wagon or the automobile is rough when traversed by the motor truck.

This has latterly been explained in the following fashion by experts of the U. S. Bureau of Public Roads: "The truck wheels rising over the small elevations and falling into the adjoining depressions deliver great hammer-like blows, the effect of which upon the road is greater by far than the dead weight of the vehicle and its load. They do not greatly wear the surface of the roads, but the shattering effect of the impact is much worse than surface wear. The deterioration is not, as formerly, a product of many vehicles and long periods, but may result from the passage of a single heavy vehicle."

Therefore, the highway engineer must be able, from time to time, to know what is taking place in service within the supporting body of the roadbed; and, again, it is equally important to him that he should have some way of ascertaining whether or not the road's structure has been compounded and laid agreeably to specifications. This is particularly true of concreted roads which may be good, bad, or indifferent, depending upon how the components are chosen, mixed, placed, and subsequently treated or exposed before the concrete has "ripened."



A pavement core removed from the road by a "Calyx" pavement tester.

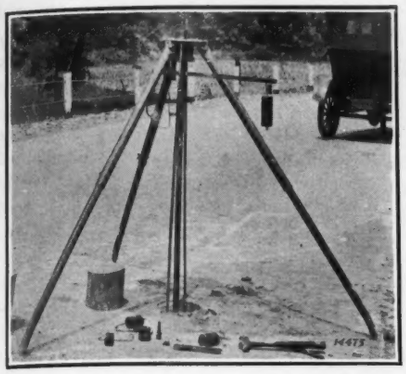
In some States, among which Pennsylvania and New Jersey are prominent, the highway departments have provided themselves with what are termed pavement testers, and these are mounted upon automotive trucks and sent broadcast wherever it is desired to extract sectional samples for laboratory examination. The field equipment consists primarily of a core drilling outfit, operated by an 8 h.p. gasoline engine which is independent of the truck's motor. Besides the drill, there are molds for casting concrete repair-plugs; bins for cement, sand, and stone, to be used in making these plugs; and various necessary tools. The trucks also carry an ingenious apparatus for determining the bearing power of the soil underlying the concrete surfacing.

As the accompanying illustrations show, the core drilling bit is attached to the lower end of a vertical shaft, which is actuated by the gasoline engine, and this shaft can be raised and lowered and its cutting pressure regulated by the operative. The drilling tool is virtually a tube of soft steel having a flat bottom edge or face. The tool is operated at 200 r.p.m.; and between the annular face of the drill and the material to be cut is interposed a thin layer of steel shot, which are fed continually to the point of attack. It is the shot which really does the actual cutting.

As soon as the core drill is in position, pressure is exerted on the bit as it rotates, and this pressure shatters the shot and converts them into hundreds of sharp-edged pieces of hard steel. These brittle fragments partly embed themselves in the soft steel face of the drill; and as they are spun around with the tool they saw away or cut into the underlying substance. The shot are supplied through the center of the bit and tend to work radially outward, but are caught by a slot in the tool and forced under the face of the drill. This cycle is repeated until the shot are ground to a fine powder which is so light that it can be swept upward by the flow of water which is directed into the tool. The primary purpose of the water is to keep the bit cool, and its secondary action is to wash the cuttings from the hole.

As the drilling proceeds, the cylindrical bit wears away an annular passage, leaving a solid core within the body of the drill. When the tool has bored its way through the concrete mass, the bit is raised and the core lifted out. Generally, the core is approximately six and one-fourth inches in diameter, and its height is determined by the vertical thickness of the concrete. Each core is marked with identifying

A "Calyx" pavement testing drill used by the Pennsylvania State Highway Department.



Apparatus for determing the bearing power of the soil.

numbers, etc., and in due time reaches the State laboratory where it is subjected to crushing or other tests. In this way, it is possible to determine not only whether the concreting was done according to specifications but also to detect any signs of failure due to vehicular impact.

On an average, it takes about twenty minutes to drill a core eight inches in length from a concrete road; and there is used up in that interval something like three pounds of steel shot, representing an outlay of approximately twenty-one cents. Before the hole in the highway is filled with a replacement plug of concrete, it is the practice in some States to make tests to determine the bearing or supporting capacity of the underlying soil. These are carried out by the aid of what is termed a soil-testing machine, which consists of a collapsible tripod supporting a compound lever mechanism by which measurable pressures can be transmitted to a rod directed downward into the earth.

The pressure so exerted tends to lift the tripod, but this is prevented by two holding-down rods with hooked ends, which catch under the nether edge of the drill hole. A graduated dial registers the depth of penetration in the sub-grade material agreeably to the load applied through a weight or weights hung on the lever arm. Time readings are made at stated intervals so that the rate of penetration may be computed and the bearing power of the soil ascertained.

When starting out on a trip, the crew of a core-drill truck is furnished with an itinerary and the points along those roads where exploratory work must be done. In addition to this, it is customary to give them a general order to drill cores and to make observations wherever unusual conditions of the highways are encountered. As a rule, the routine calls for an average of from three to four cores per mile, or approximately one every 1,500 feet. As has been well said, "The drilled cores are virtually X-rays of the finished road, and are the most reliable source of information that can be had."

Pinchus Ruttenberg, hydraulic engineer, who came from Jerusalem via London with plans to harness the power of the River Jordan in Palestine to supply the Holy City, Haifa, Nazareth and Jaffa with electric light and power has returned to Jerusalem.

HANDLING RICE HULLS WITH AIR

AN INTERESTING application of air to an ingenious system of handling rice hulls has been in economical and satisfactory use for some time at the Chicago plant of the Calumet Baking Powder Company.

For storage purposes five silos are used, 70 ft. high and 25 ft. in diameter, which hold approximately 1,000 tons of rice hulls. The hulls are delivered in bags. The system, as first installed, consisted simply of a long pipe extending from a bin adjacent to the railroad to the top of the storage bins, with a fan installed midway. The hulls were emptied from the bags directly into the bin, and the fan suction carried them through the pipe, through the blower and into the storage bin.

In operation, however, it was found that the fan broke the hulls and materially reduced their value for packing purposes. Accordingly, a rarefied collector was installed between the fan and the bin, allowing all the hulls to collect before reaching the fan. It was then planned to drop the material out of the bottom of the rarefier in front of the blast, on the other side of the fan.

But the high air pressure made this impossible, and several mechanical feeding devices were tried, all of which failed. Finally, a modification of the Venturi principle was adopted, which reduced the pressure at one point so that the weight of the hulls was sufficient to cause them to fall in front of the blast. In this way, the hulls were introduced into the bins without any breakage. Outlets from each of the bins were connected with a filter, through which all of the air escaping from the bins had to pass. The object of the filter was to prevent the dust escaping into the air and becoming a nuisance.

To get the hulls out of the bins, openings are left in the bottom and connected with a pipe to the rarefier, fan, and a pipe connected with the main factory where the hulls are used for packing purposes. Another pipe allows the excess air to escape into the open, while the hulls themselves drop to the second floor and are distributed through a long packing bin by an open screw conveyer.

This installation, it is stated in *Industrial Power*, has worked for a year and a half without trouble of any kind, and none is anticipated in the future.

COMPRESSED AIR USED FOR HYDRAULIC ACCUMULATORS

THE WELL known hydraulic accumulator which maintains a constant water pressure by means of an enormous weight of cast iron or other heavy material is seriously objectionable. It occupies much space, and is too heavy for any ordinary flooring so that special foundations must be provided. An accumulator of novel design, no details of which have come to hand has recently been patented in Germany. The pressure is maintained by compressed air and consequently no excessive weight is entailed while the apparatus can be placed wherever may be most convenient.

GETTING FINER AND FINER

According to the decrees of the labor organizations a rock-drill worker who can't get on with his job because the air or water pipes are broken must not dare touch those pipes. That is the pipe fitters job, and therefore according to the edicts of organized labor now in force the machine-man must do nothing until the pipe fitter is disposed to put in an appearance according to a recent issue of the *South African Mine Journal*. Similarly the pipe fitter, although he may be working under a dangerous piece of hanging, must on no account attempt to trim down the loose rock or to usurp the functions of the timberman whose particular job is to put a prop or stick under the dangerous ground. But what of that? What does it matter if the pipe fitter is killed so long as there is no departure from the great fiat of "Every man to his own job and one job only?"

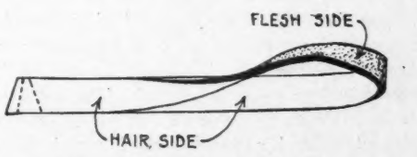
KINKS FOR CUTTING BELTS

By W. F. SCHAPHORST

SEVERAL YEARS ago the writer was taught a valuable kink for cutting belts, as illustrated in the sketch herewith. This kink, so far as I know, has never before been published.

We are usually instructed, when cutting a belt, to use a square and make the cut "absolutely square" with the sides of the belt. However, if done in the manner illustrated here it is not necessary to make the cut square. The important thing is to simply make the cut "straight."

This is done by giving the belt one turn as shown in the sketch and laying the ends one exactly over the other, both in perfect alignment. Then, by making the cut "straight" even though not square with the sides, it will be found that the ends will make a perfect fit. The cut may make an angle of 45 degrees or even more with the sides. It makes no difference.



Arrangement of belt ends for cutting so as to get a "perfect fit."

Of course it is usually best to cut the belt square, or as nearly square as possible. By cutting it square belting material is more likely to be saved than where the cut is made at an angle. But to be doubly sure, even if a square is used, it is a good plan to give the belt one turn as explained here and then if the square itself is not true, or if an error has been made in some way or other, the cut will automatically rectify itself.

At the Fairbanks, Alaska station, the Bureau of Mines will make a study of the conditions of drift placer mining with the object especially in view of recommending the introduction of mechanical means of handling gravel underground.

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—Founded 1896—

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EDITORIALS

INVISIBLE AERIAL ACTIVITIES

THE TITLE above suggests what is to us perhaps the most wonderful of all the phenomena of nature; yet, though practically unlimited, universal, everlasting, it is not generally recognized or even thought of. The air itself is invisible to begin with. It is everywhere around us and constantly coming and going, with unceasing changes of speed and direction, yet leaves no track or trace. Our eyes at any time can tell us nothing of the wind, "whence it cometh or whither it goeth."

In the exercise of the, so far as we know, most important and wide reaching of its world-functions, the collecting, the conveying and the distributing of water over all the earth, the air is not only itself invisible but the vast load it always carries is equally so. Looking up into the sky on a bright, clear summer day it is hard to believe that the medium into and through which we gaze without suggestion of visual obstruction is laden through and through with all that may be required for the production of a flooding thunderstorm, that the black clouds when they show themselves are made on the spot from the invisible material at hand and not rushed into our sight from unknown distances. When the magnificent glories of the glowing sunset unfold themselves before us the agency which spreads the colors and unceasingly changes them gives no sign of its presence but in the succession of evanescent hues as the moments pass.

What we have in mind here, however, are not exactly these strictly atmospheric manifestations but rather those which, necessarily acting in and through the air in which we are all submerged, are not strictly of the air as we isolate and understand it but extend and are operative throughout all space. We might thus say that invisibility is a characteristic not alone of our atmosphere and the things for which it is directly responsible but of the inter-activities of the whole wide universe. On a clear, dark night, far away from the confusing lights and sights of the great city, we step out into the open and at once our eyes are in perfect visual individual communication with any one or all of the host of shining stars which crowd the sky.

We speak of rays of light, and think, when we see anything, of a straight line of illumination from the object seen to our eye, and this no matter where we stand or how we may move from place to place. These straight lines, thinking now of the stars alone, suggest unimaginable interferences and entanglement and, whether visible or not, would seem to be self evidently impossible. While we speak of rays of light we talk just as glibly of waves of sound; then why not also waves of light? though they too bring complications of their own. It really matters little here as to what may be the means of light transmission since, in any case, the light in conveyance is absolutely invisible. And this invisibility would seem to be a necessary part of the scheme, since to look across or into or through the maze of lights coming or going would impair or kill the penetration of the vision to points beyond.

When we come to some recognition and appreciation of this everlasting paradox of the invisibility of light it will be well to familiarize ourselves also with the additional paradox of the inaudibility of sound as transmitted long distances and necessarily also through the air. The wireless wonder of Marconi is now a plaything of the amateur and a filler of the idle hours. Music in all its manifestations, vocal or instrumental, the sermon, the political speech or whatsoever appeals to the ear is transmitted miles and miles and is heard simultaneously by individuals or by crowds located far away and far apart, and between the source of the sound and the ears of the auditors no hint of what is going on. All the ordinary sounds of daily life are heard as usual and neither interfere nor are interfered with.

Now that human activities are using the air more and more, crowding it, so to speak, we may be thankful that we cannot see or hear all that is going on. Conversely we may be equally thankful that the invisibility and inaudibility of which we speak still have their limitations, and that neither can be appropriated or employed at will by any human ingenuity. We may be sure, for instance, if this sentence can be understood, that we will never see an invisible airplane nor hear one that is inaudible.—*R.*

SIMPLIFIED PRODUCTS REDUCE COSTS

AT TIMES like the present we hear a good deal about the necessity to reduce the price of labor in order to recover business prosperity Men lose their patience with the labor situation, condemning labor unions for the ills that trouble us. They forget that the price of labor, more than any other thing which goes into the cost of the project, is subject to economic conditions.

A manufacturer can cut the price of his material, even to the extent of losing money, in order to reduce his inventory or to keep down his overhead. Labor, however, cannot be handled in this way. It cannot be driven down with a club or through the edict of a group of men. It comes down through natural conditions, brought about by bad business, lack of employment, etc. The longer the bad business continues, and the more severe the depression, the sooner will labor come down.

As nobody wants to encourage the long depression it is better to let these natural conditions work, if they must, and turn our attention to reducing costs by improving and simplifying the product through new inventions in tools and in the nature of the product.

As an instance of this, there has been recently recorded a meeting of manufacturers of men's trousers. The jacket of a working man lasts much longer than his trousers. This being a fact there has been built up a large industry in making workmen's trousers and nothing else. These men decided that the only way for them to get on their feet was to get labor prices down. One of them, a man of vision, went back to his shop and studied a pair of workmen's trousers with the idea of seeing how he could simplify it. He observed that these trousers, and in fact all trousers, are built with a band at the top, similar to that of a belt. The idea occurred to him to do away with this band as there appeared to be no practical necessity for it. He built his trousers without the band and in this way cut down the cost. He is now busy while the others are inactive.

THE SURE AND ONLY ROAD TO PROSPERITY

IF THERE is any one thing which more than any other is an index of prosperity it is that a large volume of labor is employed. What leads to large employment of labor? It is increased production. And what leads to increased production? It is low cost of output. It is a fallacy to suppose that by producing as little as possible more men will have to be employed. Where does employment come from? It comes from consumption, and where does consumption come from? It comes from ability to buy. The cheaper things are made and sold the more of these things will be consumed, hence the greater will be the consumption and the greater the number of men that will have to be employed.

Therefore, we conclude that to reduce the cost of a product is the surest way to employ labor and to make prosperity. Markets of the

world are always open in large volume for all products, provided that they can be supplied at reasonable figures. It is as much to the interest of labor as of capital to employ the best scientific methods of production, to simplify the product as far as may be practicable, to introduce new inventions and to stimulate the output per man per hour, so that the buying power of the world may be brought into action.

The Ford car is the best illustration of this. These works are busy because of scientific production. Men are employed and wages are good because of scientific production.

EXPANSION MOVEMENT FOR ROUMANIAN MINES

ROUMANIA, which experienced the fall of two governments within as many months last winter, and which is now hopefully emerging from its most recent financial crisis, is possessed of mineral resources which, when more fully exploited, are expected greatly to assist the economic restoration of that country. QUEEN MARIE of Roumania who was an English princess before her marriage, a granddaughter of the late QUEEN VICTORIA, and who became queen when her royal husband ascended the throne in the autumn of 1914, is expected to visit the United States at the end of this year. It is understood that in the event political conditions permit of her coming to America, one part of her mission will be in connection with the financial and economic status of her country.

To the mining engineer and industrialist, Roumania, with its partly developed natural mineral riches, presents an interesting field for assured business expansion. As a result, English, French, Dutch and American capitalists, working with Roumanian men of affairs, have already undertaken petroleum and mining projects on a considerable scale in past years, and are looking forward to still greater operations.

The total working capital of the Roumanian banks and industrial corporations, however, is comparatively small for a country of 18,500,000 population, or almost half of the total population of the British Isles, being only 600,000,000 lei in 1919, though this has no doubt been largely increased in the three intervening years. The leu has dropped heavily in exchange value, like most European currency units, but better days are predicted for it, particularly if certain contemplated foreign loans are effected.

The country is an important political factor of the so-called Little Entente, (Roumania, Jugo-Slavia and Czecho-Slovakia) but what the business leaders of Bucharest are looking forward to is less of politics and the cessation of the heavy drain of a top-heavy standing army. The trend of business thought in Southeastern Europe, as in most parts of the world, is to rid the state of old-fashioned diplomatic and militaristic ambitions and to get down to the safe bed rock of production in mining, manufacturing and commerce, with the full encouragement and aid of the state.

That Roumania has a solid foundation of resources upon which to build is evidenced by figures brought to the United States this spring by an American business man, S. SULFRIN, who made an apparently thorough investigation of conditions in Roumania and Bessarabia. He obtained data on the extensive Roumanian coal mines and copper and iron properties, and found that there were excellent inducements for the coöperation of American operators.

The natural resources of Roumania rest at present upon average annual extractions of 2,000,000 tons of oil, 350,000 tons of salt, 2,000,000 tons of coal, 3,000 kilograms of gold, 9,000 kilograms of silver, some 1,000,000 cubic metres of natural gas, in the Transylvania region, and some small iron or deposits. The country's navigable waters aggregate a surface of 1,200,000 hectares, and it also has 300 kilometres of shore line on the Black Sea.

Mining interests with headquarters at Bucharest state that with modern mining equipment, including the most efficient compressed air installations, a number of which have already been purchased in the last year, that Roumania's wealth in the earth can be extracted more rapidly and more economically, for the benefit of the entire country. These desirable developments depend, in some degree, upon foreign financial arrangements, but signs of success in this direction are not wanting.

The Aguila Franco-Roumanie, at Ploiesti, is a large oil interest that in the past has had its years of prosperity and which is now preparing for larger production with proportionate profits. The mining groups are building also for the future. Such seemingly remote business building is of larger potential interest to the Western Hemisphere than appears at first blush, as men like WILLIAM NELSON CROMWELL, of New York, one of the best informed men of America on Roumanian affairs, have been able to testify. Success in Roumanian industry building means a radiated share of business on this side of the water. It is good policy, therefore, for America to be both a practical and a sympathetic ally of Roumania in her mining, industrial and trade expansion programme. F. J. T.

AN ARTIFICIAL ANALYSIS OF ST. LAWRENCE PROJECT

THERE WAS recently held at Washington a debate on the St. Lawrence seaway between the Governor of New York and the Governor of Kansas. This debate has been described as "a three hours' wrangle." This was expected by those who have studied the St. Lawrence project. Governors of states however able, are not the proper persons to discuss an engineering and economic problem of this kind.

The Governor of New York assumed the position of an advocate, and being an able lawyer himself, handling a difficult situation, he treated this scientific problem from a lawyer's standpoint. Engineers approach a subject from the standpoint of its practicability, based upon an analysis of this particular subject and not upon traditions or precepts. It is not with them the question of making the best argument for a client, guilty or innocent, but they dig into the facts and reach deductions through facts and figures.

The Governor of New York in this debate took the ground of a clever advocate when faced with difficulties by asking that Congress authorize an impartial investigation of the project, stating that if such investigation should show its feasibility, necessity and economic justification then he would support it. This statement brought prolonged applause and cheers. At best it is begging the question.

An international, impartial commission was established by Congress several years ago. This commission sat in different parts of the United States and Canada over a period of surely two years, taking testimony pro and con. It was composed of men of high standing in character and ability. They reached a unanimous conclusion in favor of the project. Their intention to be fair and just is shown in the advice given that the plans be given further study.

A SERBIAN'S CONTRIBUTION TO TELEPHONY

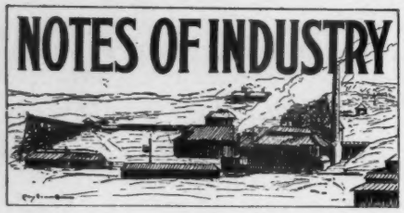
CONSPICUOUS among the hundreds of inventions which have brought America's telephone systems to their high development are those of Dr. MICHAEL IDVORSKY PUPIN.

Attention is called to the achievements of this great scientist in an interesting research narrative recently distributed by the Engineering Foundation.

Although for many years an American citizen by adoption, MICHAEL PUPIN was born in a village near Belgrade, Serbia. At the age of twelve he began summer vacation service with other boys as assistant to the guardians of the villagers' herd of oxen, and at the same time his studying in Nature's own laboratory of the wave transmission of sound.

Now, among the arts of the herdsmen in which the boys were trained, was the art of listening through the ground. A knife with a long wooden handle was stuck in the ground. One boy who was being trained would put his ear to the handle and listen, while another boy 30 or 40 yards away, would strike his knife similarly stuck in the ground. The first boy would have to tell the direction and guess the distance. This first lesson in wave transmission set young PUPIN thinking. He soon observed, as herdsmen before him had, that sounds from the knife carry much farther through hard solid ground than through plowed ground.

Finally those germs of thought bore fruit in many scientific discoveries and inventions having to do with wave transmission, especially of sound and electricity. Among these inventions was the Pupin "loading coil," which greatly advanced the possibilities of successful long-distance telephony. A few years ago, when Chief Engineer CARTY, of the Bell Telephone System, stretched his wires from the Atlantic seaboard to the Pacific coast of the United States, and President THEODORE N. VAIL, of "A.T. and T.," first made a human voice heard across a continent, there were Pupin coils at intervals of eight miles in that transcontinental line. In the whole world today there are more than three-quarters of a million Pupin coils in use in telephone lines, of which 600,000 are in the United States.



The Detroit Edison Company has recently put into service what is said to be the largest steam boiler in the world. It has more than 29,000 sq. ft. of heating surface and is rated in excess of 9,200 h.p.

Owing to difficulties encountered in obtaining the services of competent typists notice is given by the official Gazette that in order to avoid delays the Patent Office reserves the right to furnish photostat copies in lieu of typewritten copies, in filling orders for copies of its records, unless otherwise specifically directed.

We have here at last a hint that to live long one should get into a gas works. William Hambleton, who is hale and hearty at 97, entered the employ of the Liverpool, Eng., Gas Company in 1849, and did not retire until 1920 after 71 years of continuous service.

The Air Reduction Company has recently perfected all the necessary arrangements for the amalgamation of the Davis-Bournonville Company, the largest manufacturers of oxy-acetylene apparatus. The manufacturing and sales organizations will thus be considerably enlarged.

The largest map in the world is the ordnance survey map of England, containing over 108,000 sheets, and costing about $1,000,000 a year for twenty years. The scale varies from ten feet to one-tenth of an inch to a mile. The details are so minute that maps having a scale of 25 inches show every hedge, fence wall, building, and even every isolated tree in the country. The plans show not only the exact shape of every building, but of every porch, area, doorstep, lampost, railway and fire-plug.

A new airplane engine which, though weighing only 2,200 lb., develops 1,000 h.p. It has been constructed by D. Napier & Son, Ltd., of England.

The use of compressed air, which is furnished by the engine's operation of the tire pump, has been found very convenient for cleaning the upholstery of the automobile. This device will be found serviceable when getting the particles of dust out of the tufts of the cushions and other inaccessible places.

The Milan school of Milan, Wash., has completed the installation of a compressed air water system operated by electric power. A well was dug near the school house, which had so large a flow that a three-inch stream being pumped for a day and a half did not lower it.

There are some people who would abolish the use of paper money altogether substituting the actual metal therefor. There being but a small amount of coin available for this purpose compared with the volume of the world's paper currency, they say the result would be a general scaling down of commodity prices in the exact ratio which gold bears to the currency. This, they say, will be a sure cure for both inflation and deflation since the money base will be absolutely inelastic. This theory has many advocates, as has the theory which seeks to stabilize the dollar by theoretically adding to or subtracting from its coinage value as commodity prices fall or rise.

All the properties of the Arizona Copper Company, Limited, Clifton, Arizona, have been sold and transferred to the Phelps Dodge Corporation. The company, therefore, desires that all communications affecting the operating departments of the Arizona Copper Company, Limited, should be addressed to Joseph P. Hodgson, Manager, Morenci Branch, Phelps Dodge Corporation, Morenci, Arizona. Communications relating to the Store Department should be addressed to L. J. Owen, Manager, Phelps Dodge Mercantile Company, Morenci Stores, or C. B. Nonnamaker, Manager, Phelps Dodge Mercantile Company, Clifton-Metcalf Stores.

Personal Intelligence

Mr. Henry A. Laughlin, one of the pioneers of the iron and steel industries in the United States, died recently at his home in Chestnut Hill, a suburb of Philadelphia.

Mr. Laughlin was chairman of Laughlin & Co., Ltd., until that concern was absorbed by the Jones & Laughlin Steel Company. He was a director in the last named company when he retired in 1900.

* * *

Mr. Harmon F. Fisher has been appointed engineer with the Research Division of the American Petroleum Institute. Mr. Fisher has been a consulting engineer and was previously in charge of operating U. S. Government helium plant No. 3, Petrolia, Texas.

* * *

Mr. Herbert Tally, chief engineer of the Hercules Powder Co., Wilmington, Del., has resigned to take an important executive position with the United States Powder Co., of Terre Haute, Ind.

* * *

Mr. Ralph M. Sitterley, of 149 Broadway, New York, expects to leave for Europe this month where he will represent American manufacturers abroad.

* * *

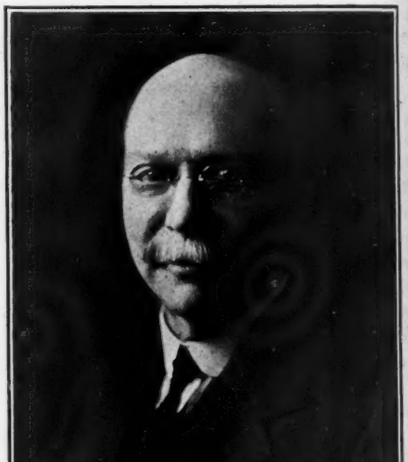
Mr. Daniel L. Norris, construction superintendent for the George A. Fuller Construction Company, died at his home in Newark of pneumonia.

Mr. Norris had charge of many important building projects, including the erection of the Biltmore, Commodore, and Plaza hotels, the National City Bank and R. H. Macy department store, all of New York. He was 52 years old.

ALEXANDER M. GOW

THE RECENT DEATH of A. M. Gow, assistant chief mechanical engineer of the Oliver Iron Mining Co. at his home in Duluth, Minn., after several months' illness, was a severe loss to a multitude of friends and admirers throughout the Michigan and Mesabi iron ranges, in the development of which Mr. Gow played a distinguished part for the last seventeen years. In this time Mr. Gow had complete charge of the mechanical activities of the Oliver Iron Mining Co., and to his efforts was due in a great measure the introduction of larger types of machinery in open pit work and underground mining.

Mr. Gow was a mechanical engineer of great ability and much inventive genius, which qualities, combined with an energetic disposition were the elements of his remarkable success in his chosen field. He had a very great many friends not alone within his professional sphere and inside of business circles, but owing to his wide interest in many subjects, he came into contact with many others who were unfailingly impressed by his likeable personality and firm character.

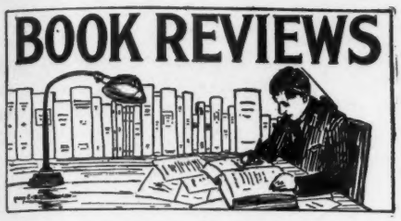


Alexander M. Gow

Alexander M. Gow was born in 1861 at Dixon, Ill. In 1879 his family moved to Washington, Pa., where he entered Washington and Jefferson College of which his grandfather, John L. Gow, had been an early trustee and his father, a graduate in 1846.

After leaving college Mr. Gow entered the Ohio State University and graduated in mechanical engineering in 1883. He then spent the next five years in the motive department of the Pan Handle Railroad when he entered the employ of the Fuel Gas & Engineering Co. in Pittsburgh. This latter company was organized by George Westinghouse for the purpose of controlling fuel gas for heating and supplying electricity for lighting in large cities. However, the venture proved a failure and Mr. Gow then undertook engineering work in various other directions mostly in connection with the chemistry of gases and the metallurgy of copper before his association with the Oliver Iron Mining Co. in 1905.

BOOK REVIEWS



MODERN TUNNELING, by David W. Brunton and John A. Davis. With chapters on Railroad Tunneling by J. Vipond Davies. A second edition, revised and enlarged. 612 pages. 6x9 in. 119 illustrations. Cloth. $6.50 postpaid. New York; John Wiley & Sons, Inc.

THE SCOPE of this book has been materially widened, in this second edition, by the inclusion of new matter dealing with the various classes of large sized tunnels. A brief study of enlarged tunnel construction is now also presented, dealing chiefly with modern railroad tunnels such as those under the Hudson and East Rivers, and New York and Liberty Tunnels, Pittsburgh. "The increased use of large sized tunnels for railroad and highway purposes," to quote from the introduction to this edition, "has advanced rapidly with the development of mechanical appliances which aid in the construction of these large sized structures to furnish improved means for conducting the various classes of transportation."

The story of progress in tunneling methods is in truth also a story of the development of compressed air applications, as the two have been most intimately associated in almost every kind of tunnel work. Pneumatic rock drills, mucking machines, locomotives, tunneling shields, caissons, concrete conveyers, cement gun, etc., suggest a few of the many compressed air uses. Throughout the book, the authors have placed due emphasis upon the proper selection and use of such pneumatic equipment.

The selection of Mr. J. Vipond Davies, engineer of world-wide reputation as a builder of railroad and other tunnels, as contributor to this new edition, cannot fail to add greatly to the high esteem in which this standard book is held by constructors of tunnels generally. There are but few books on the subject of tunneling and most of the material contained, although interesting and valuable historically, is now somewhat obsolete. This book, is intended to supply up-to-date information as to the present status of tunnel work, with brief analyses of methods and costs, and emphasizing those which have proved safe, efficient and economical.

MATERIALS OF CONSTRUCTION, by the late Adelbert P. Mills, Professor of Cornell University. Edited by Harrison W. Hayward, Professor of Materials of Engineering, Massachusetts Institute of Technology. Second Edition. 476 pages. 6x9 inches. 192 illustrations. Cloth. $4.00 postpaid. New York: John Wiley & Sons, Inc.

THIS WORK WAS originally undertaken to meet the need for a general text-book covering the manufacture, properties, and uses of the more common materials of engineering construction in a comparatively concise and thoroughly modern manner. The first book by Professor Mills proved of such great value to students and engineers that no fundamental changes have been made in this revised edition.

This new edition, edited by Prof. Hayward, contains new material prepared by him, while several chapters have been condensed and parts of others have been rewritten. The book has also been divided into sections.

Manufacturing processes are treated with sufficient detail for the general engineer or student, but the book does not take up chemistry or metallurgy to such an extent as to make the work unintelligible to this class of readers.

Several members of the faculty of the Massachusetts Institute of Technology have given valuable advice and assistance in the preparation of this new edition. In its revised form this book has a renewed value to students in materials, as well as to every engineer engaged in structural work.

EDITORIALS AND EDITORIAL-WRITING, by Robert Wilson Neal, formerly of the World's Work, Boston Sunday American, Springfield Union, etc. Author of Short Stories In The Making, Today's Short Stories Analyzed, etc. Formerly with University of Cincinnati, Rutgers College and Massachusetts Agricultural College. With an Introduction by Henry J. Haskell, Asso. Editor Kansas City Star. 395 pages. 6x9 in. Cloth. $3.00. Springfield, Mass: The Home Correspondence School, Inc.

THE WHAT AND the how of the editorial article, clearly and thoroughly analyzed as to subject, content, structure, variation, typography, etc., suggests in brief the scope of this book. The text throughout is illustrated with editorial examples from leading journals of the day so that the reader and student are given opportunity to study conveniently the work of the world's foremost writers and also reproductions of representative editorial pages. It offers a comprehensive digest of contemporary thought concerning journalism and the editorial.

An outline for the study of editorials is given for those who, for professional or other reasons, wish to increase their intimate understanding of editorial writing or to make themselves proficient in its many applications. The outline involves such essentials as I, Adaptedness; II, Purpose, Spirit and Type; III, Sources; IV, Structure and development; V, Tone, style and diction; VI, The editorial page. It provides a means of studyiny effective editorial presentation as found in actual practice, in current journals and periodicals.

The Edison Lamp Works of General Electric Company have issued several interesting booklets of lighting data giving information on the Lighting of Metal Working Plants, The Eye as Affected by Illumination, Lighting of Signs and Billboards, Lighting of the Clothing Industry and The Lighting of Large Dry Goods and Department Stores. They give valuable information on the quality and degree of lighting required for seeing with ease and comfort and should prove of great aid in the layout of lighting systems.

Engineers, mechanics, electricians and students who are seeking to broaden their knowledge of general engineering subjects will be interested in a new set of Engineers' and Mechanics' Guides recently published by Theo. Audel & Co. The entire set, in which there are eight volumes, is attractively described in a booklet issued by the publishers. The value of a complete encyclopedia of the working knowledge that engineers and mechanics need have is set forth in an interesting way and the increased earning power of accurate knowledge of a subject made clearly apparent. The aim of these new guides, it is stated, is to present concisely and in practical language the very latest in modern engineering; with questions, answers, calculations, tables, etc., arranged for study and for convenient reference.

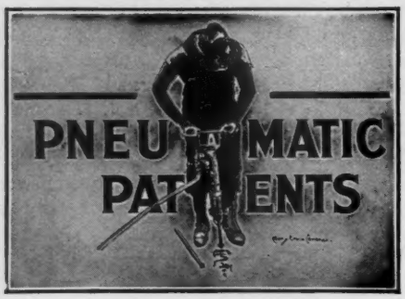
The American Welding Society, in their bulletins of society proceedings, is offering much valuable information on welding and its industrial application. The Society acts as a clearing house for information related to this subject. Through papers and monthly meetings of local sections of the Society an opportunity is created for individual manufacturers, engineers, superintendents, operators, etc., to contribute their own knowledge and at the same time receive the benefit of the combined knowledge. A recent bulletin contains comprehensive articles on Arc Welding of Cast Iron and Safeguarding the Oxy-Acetylene Process, and also miscellaneous items of interest.

World Petroleum Conditions are discussed in a very comprehensive manner in the December 21, 1921, Bulletin of the American Petroleum Institute. It contains the addresses delivered at the general sessions of the 2nd annual meeting of the American Petroleum Institute in which various aspects of the world petroleum situation were discussed by men of world prominence in the industry.

Hercules Flotation Oils are described in a booklet just issued by the Hercules Powder Co. It gives information on the methods generally applied in testing for the purity of a flotation oil and instructions for detecting adulteration. Specifications of the six standardized Hercules Pine Oils are also given in detail.

A booklet has just been published by The Hydraulic Society entitled: "TRADE STANDARDS IN THE PUMP INDUSTRY." This work explains what is meant by trade pumps, plain fitted pumps, or brass fitted pumps; what is considered standard equipment for a trade pump and what the manufacturer considers as extras; typical sizes of trade pumps are shown; and definitions are given of terms used in the industry, such as static head, total dynamic head, suction lift, static suction lift, dynamic suction lift, etc. It is published as showing what the society and its members think is good practice and is recommended as a guide for buyers and sellers to govern themselves by if nothing to the contrary has been agreed upon.

In this way it is believed that the booklet will eventually be looked upon as a standard, like the standards established by the A. S. M. E. To facilitate this aim, the society is giving the booklet wide distribution, both to pump manufacturers who are not members of the society and to the trade. Copies can be secured from the members of the society or from the secretary.



JANUARY 17

1,403,583. PERCUSSIVE ROCK-DRILLING APPARATUS. Richard Henry Adams, Cobalt, Ontario, Canada.
1,403,591. PNEUMATIC ACTION. William C. Collignon, Chicago, Ill.
1,403,650. APPARATUS FOR SEPARATING GASES FROM LIQUIDS. Benjamin Skidmore, Jr., Chicago, Ill.
1,403,839. FLUID-PRESSURE BRAKE DEVICE. Tom R. Bristol, Atlanta, Ga.
1,403,846. FLUID-PRESSURE BRAKE. John W. Cloud, London, England.
1,403,878. SAND-DISTRIBUTING APPARATUS. Thomas Leroy Swearingen, Danville, Ky.
1,403,879. VACUUM CAPPING MACHINE. Thomas L. Talliaferro, Chicago, Ill.
1,404,102. TAIL-VALVE APPARATUS FOR COMPRESSED-AIR BRAKES. Robert Dubois, Paris, France.
1,404,179 FLUID - PRESSURE - ACTUATED CLAMP PARTICULARLY FOR ROCK-DRILL MOUNTINGS. John Herbert Veasey, Johannesburg, Transvaal, South Africa.

JANUARY 24

1,404,196. BURNISHING MACHINE. Frederick M. Furber, Revere, Mass.

4. In a machine of the class described, a tool, a source of compressed air, means for effecting substantially *isothermal expansion of the air* from the source, an electric unit, means for bringing the air in contact with the unit to heat the air, and means for conveying the heated air to the tool.

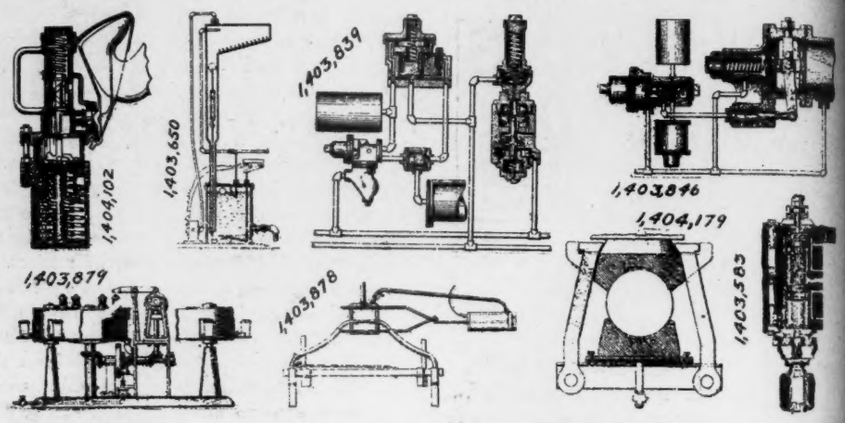
1,404,211. PROPORTIONAL FUEL MIXER. Garnet W. McKee, Rockford, Ill.
1,404,470. AIR PUMP. John L. Nilson and John Prince, Chicago, Ill.
1,404,529. VACUUM FEED. John J. Kieran, New York, N. Y.
1,404,699. SUCTION SWEEPER. Fred H. Burgher, Lakewood, Ohio.
1,404,689. AIR GUN. Frederick Humbert Fairweather, Bridgeport, Conn.
1,404,716. APPARATUS FOR SEPARATING AND PURIFYING WHEAT AND OTHER CEREALS AND THEIR PRODUCTS. James Higginbottom, Liverpool, England.

JANUARY 31

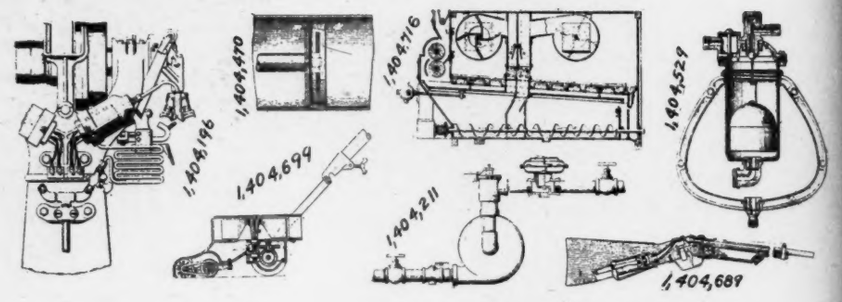
1,404,903-4. SANDING DEVICE FOR RAILWAYS AND THE LIKE. Charles Spencer, Hamilton, Ontario, Canada.
1,405,012. AIR GUN. Leopold C. Schneider Glenside, Pa.
1,405,084. DRILL SHARPENER. Wade H. Wineman, Chicago, Ill.
1,405,095. VACUUM CLEANER. Gustav A. Brachhausen, Rahway, N. J.
1,405,166. MILKING MACHINE. Warren A. Shippert, Dixon, Ill.
1,405,173. PUMPING APPARATUS. Hervey J. Wheeler, Brooklyn, N. Y.
1,405,204. MACHINE FOR MAKING HOLLOW GLASSWARE. Joseph B. Graham, Evansville, Ind.

FEBRUARY 7

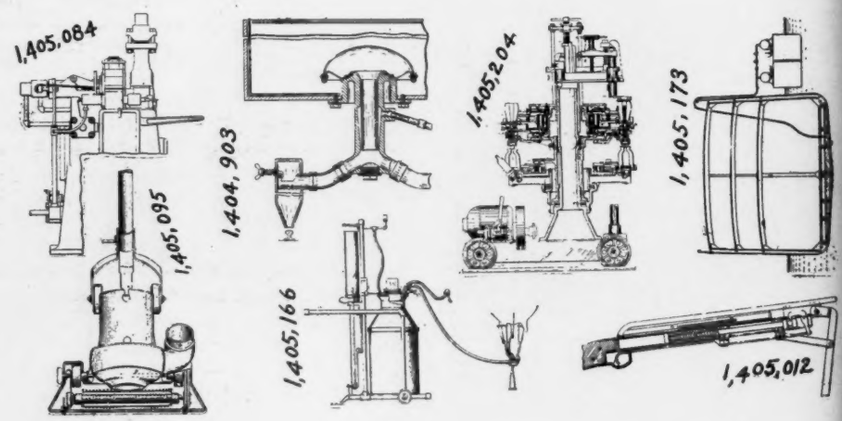
1,405,399. AIR CLEANER. Frank A. Donaldson, Minneapolis, Minn.
1,405,397. AIR PUMP FOR MOTOR VEHICLES. Clare H. Camburn and William E. Camburn, Tecumseh, Mich.
1,405,461. PRESSURE REGULATOR. Alfred Swensen, Morton Park, Ill.
1,405,520. AIR-FEEDING DEVICE. John Y. King, Lansdowne, Pa.
1,405,595. LIQUID-ELEVATING APPARATUS. Henri Kapferer, Paris, France.
1,405,613. APPARATUS FOR EXTRACTING DUST AND FUME FROM GASES OR AIR IN WHICH THEY ARE CARRIED IN SUSPENSION. Humphreys Milliken, New York, N. Y.
1,405,664. PNEUMATIC GUN. Henri Boileau, Bois-Colombes, France.
1,405,706. AIR GAUGE. Dozier Thornton Bentley, Sacramento, Calif.
1,405,907. AIR PUMP. Daniel Gordon Edwards, Hopkinsville, Ky.



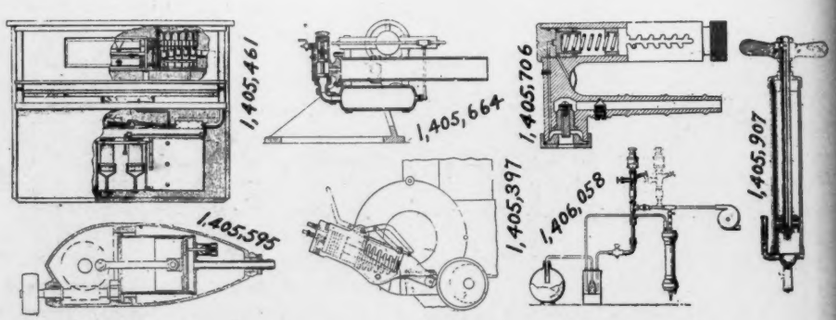
January 17



January 24



January 31



February 7